PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

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Corrosion
Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
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X-ray tubes
Induction accelerators
Cyclotrons
Amplifiers
Radio-wave propagation
Mechanical engineering
Heat engines
Illumination
Metallurgy

NOTE ON THE ARRANGEMENT OF ABSTRACTS

The Abstracts are classified by subject according to the Universal Decimal Classification, and arranged in order of their U.D.C. numbers, which are printed at the head of the Abstract on the left. Abstracts on any particular subject can be located by first consulting the abridged tables of the U.D.C. published with the January number, or the Annual Alphabetical Subject Index, and then referring to the appropriate U.D.C. number in the text. The main headings are listed above.

An Abstract of interest under more than one head has additional U.D.C. numbers, linked by the colon sign, ":" e.g. "536.21 : 548.0 Conduction of heat in crystals." The Abstract is printed once only, under the main number, e.g. in the section "HEAT 536," but Cross-references are inserted under the other numbers. e.g. "548.0 : 536.21 *see Abstr.* 1234" in the section "CRYSTALLOGRAPHY 548." These Cross-references should be investigated, therefore, when a particular section is being searched, as they contain additional matter relevant to that section. A Cross-reference does *not* refer to the Abstract which appears immediately above it.

[*Continued on page* 3 *of cover*

016 : 53 = 3 *see Abstr.* 2315

MATHEMATICS 51

517.522.2 2290

The summation of a particular type of power series. WILLIAMS, J. *Phil. Mag.*, **39**, 450–4 (*June*, 1948).—The series summed is $\Sigma a_n z^n/n!$ where the a_i satisfy a recurrence relation. L. S. G.

517.566 2291

On an identity involving *E*-functions. MACROBERT, T. M. *Phil. Mag.*, **39**, 466–71 (*June*, 1948).—A continuation of earlier work [Abstr. 709 (1941)]. Some multiple integrals involving modified Bessel functions are evaluated by means of the identity. L. S. G.

517.6 : 531.25 *see Abstr.* 2356

517.65 2292

A formula for expanding an integral as a series. WILLIS, H. F. *Phil. Mag.*, **39**, 455–9 (*June*, 1948).—The integral is $I = \int_a^b f(x)F(x)dx$, where $F(x)$ is oscillatory. The series for I involves the derivatives of $f(x)$. Explicit formulae are given for the cases when $F(x)$ is ε^{-mx}, $\sin mx$, $\cos mx$, $J_0(mx)$, $J_1(mx)$, $(\sin mx)/x$ or $\varepsilon^{-m^2x^2}$, and the integral is taken over an infinite range. L. S. G.

517.65 : 531.252 2293

On the application of Laplace pairs to the analysis of relaxation curves. MACEY, H. H. *J. Sci. Instrum. Phys. Ind.*, **25**, 251–3 (*July*, 1948).—The technique of using known Laplace pairs to find the distribution function of the relaxation coefficient or relaxation time in stress-strain analysis is described. A number of suitable transforms are given, and it is shown that one, involving the use of the square root of the time, leads to a particularly simple analytical method of attack on this problem. A.

517.9 : 537.534.74 : 539.152.1 *see Abstr.* 2526

517.947.42 : 621.3.011 2294

A form of Laplace's equation. BARTLETT, A. C. *Phil. Mag.*, **39**, 326–7 (*April*, 1948).—If ρ_1 and ρ_2 are the principal curvatures of a surface $V(x, y, z) = \text{const}$, at a given point, it is shown that Laplace's equation may be written in the form $\partial^2V/\partial n^2 + (\rho_1^{-1} + \rho_2^{-1})\partial V/\partial n = 0$ where n is the normal at the point. The form of the equation in the symmetrical cylinder and spherical cases follows at once from this. L. S. G.

517.948.32 : 518.6 *see Abstr.* 2297

518.5 2295

Calculating machines. *Nature, Lond.*, **161**, 712–13 (*May* 8, 1948).—Summary of a discussion at the Royal Society. Attention was confined to machines which are automatic, digital, or "general purpose." Various electrical calculators now under construction in America or Great Britain were referred to. L. S. G.

518.5 2296

Proportional plotter. BIELAK, W. M. *J. Sci. Instrum. Phys. Ind.*, **25**, 205 (*June*, 1948).—An instrument for plotting a curve representing the ratio between the ordinates of two other curves.

518.6 : 517.948.32 2297

The approximate numerical solution of the non-homogeneous linear Fredholm integral equation by relaxation methods. SHAW, F. S. *Quart. Appl. Math.*, **6**, 69–76 (*April*, 1948).—The equation is approximated by a set of linear equations, and an appropriate relaxation technique for solving the latter is developed. In an example, worked in detail, the deflection of a single span beam supported at the ends and subjected to normal and end loads, is calculated. The agreement with the exact solution is very good. The method is also applicable to Volterra's integral equation. L. S. G.

518.61 2298

The use of interlacing nets for the application of relaxation methods to problems involving two dependent variables. GILLES, D. C. *Proc. Roy. Soc. A*, **193**, 407–33 (*July* 21, 1948).—In the solution, by relaxation methods, of partial differential equations involving more than one dependent variable, it has been customary to find the values of all such variables at the nodes of one net. By considering the relative accuracy of the finite difference approximations to the individual terms of the equations, and for other reasons, it is suggested that values of some of the variables be determined at the centres of the meshes, which amounts to using two interlacing nets. This idea is developed, and the method is applied to a variety of problems. A.

519.2 2299

The mathematical description of certain breakage mechanisms leading to the logarithmico-normal distribution. EPSTEIN, B. *J. Franklin Inst.*, **244**, 471–7 (*Dec.*, 1947).—If the distribution of particle size in an ideal aggregate can be assumed to be the result of a large number of successive random subdivisions then it will be approximately lognormal. The author gives a fairly simple mathematical treatment of the problem. N. L. J.

519.21 = 4 2300

Observable quantities and random functions. ARNOUS, E., AND MASSIGNON, D. *C.R. Acad. Sci., Paris*, **226**, 318–20 (*Jan.* 26, 1948) *In French.*—A general discussion of the relationships between observables and random functions. The condition that an observable be a random function of time is that a certain set of operators form an Abelian system. L. S. G.

519.21 = 4 2301

Random functions of the second order and simultaneous random functions in quantum theory. Their representation in Hilbert space. ARNOUS, E., AND MASSIGNON, D. *C.R. Acad. Sci., Paris*, **226**, 557–9 (*Feb.* 16, 1948) *In French.*—Continuation [Abstr. 2300 (1948)]. Some properties of 2nd-order functions are outlined and related to the representation. When the probability laws attached to the random functions have moments of all orders, certain vector spaces are replaced by rings of operators. L. S. G.

519.21 = 4 2302

Equations of evolution of probability laws and the theory of transfer for second-order random functions. ARNOUS, E., AND MASSIGNON, D. *C.R. Acad. Sci., Paris*, **226**, 1127–9 (*April* 5, 1948) *In French.*—Continuation [Abstr. 2301 (1948)]. It is shown how the equations of the probability laws and of transfer, such as arise in kinetic theory, may be derived. The equations of transfer include equations of the Euler type in hydrodynamics. L. S. G.

519.214 2303

Some probability distributions connected with recording apparatus. DOMB, C. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 335–41 (1948).—The apparatus has a finite resolving time, and a recorded event is followed by a dead interval of time of a certain length, during which another event is unrecorded. The probability distribution of recorded

events [Abstr. 2122 (1936)] is complicated. The Laplace transform of this distribution, which is relatively simple, is now found. The transform method is also used to determine the asymptotic distribution of recorded events for large times of observation. L. S. G.

519.214 : 539.13 2304

The statistical distribution of the length of a rubber molecule. MORAN, P. A. P. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 342–4 (1948).—A chain consists of n links of equal length, successive links being at a fixed angle to each other but otherwise random. The conjecture, that the end of the $(n + 1)$th link tends, as $n \to \infty$, to a certain 3-dimensional normal distribution, is proved. L. S. G.

519.24 : 621.385.15 2305

A statistical theory of cascade multiplication. WOODWARD, P. M. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 404–12 (1948).—A method is described for deriving the semi-invariants of the probability distribution for the number of output electrons after a number, n, of identical stages of multiplication. This distribution is not of the Poisson or Gaussian types, but has a limiting form as $n \to \infty$. In the case in which each stage replaces a single primary electron by a Poisson distribution of secondaries, the output distribution is still not Gaussian unless the mean amplification per stage $\gg 1$. Application to the secondary emission electron multiplier is described. L. S. G.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522/523 2306

Recent advances in science. Astronomy. HUNTER, A. *Sci. Progr.*, **36**, 70–8 (*Jan.*, 1948).—Subjects: The 200-in telescope; daylight detection of meteors by radar; time from the transit circle.

523.11 : 523.841.11 : 539.17 = 3 2307

Nuclear physics and cosmology. UNSÖLD, A. *Z. Astrophys.*, **24** (*Nos* 3–4) 278–305 (1948) *In German.*—Various estimates of the age of the universe are discussed. Maximum ages for main sequence stars are calculated, assuming energy generation by conversion of H to He. The frequency of supernovae outbursts is found to be consistent with the hypothesis that such outbursts are a stage in the evolution of short-lived bright stars. The origin and relative abundances of the elements is also discussed. R. A. N.

523.11 : 530.12 2308

A feature of Milne's universe. GLEISSBERG, W. *Phil. Mag.*, **39**, 324–5 (*April*, 1948).—It is proved that if the local density is 5×10^{-28} gm/cm^3, the sum of the potential and kinetic energy as computed by any observer for all particles in his neighbourhood is zero. L. S. G.

523.53 : 551.510.535 : 621.396.9 2309

Characteristics of radio echoes from meteor trails: I. The intensity of the radio reflections and electron density in the trails. LOVELL, A. C. B., AND CLEGG, J. A. *Proc. Phys. Soc., Lond.*, **60**, 491–8 (*May*, 1948).—Formulae are derived for the intensity of the radio wave scattered from a meteor trail on the assumption that the electrons are created in a long narrow column, of diameter small compared with the wavelength of the radio wave. Experimental work is described which shows that the predicted variation of received power with wavelength is correct for the wavelength range 4·2 m to 8·3 m, and according to preliminary results down to 1·4 m. The formulae can then be used to measure the electron density in the trails of meteors. Of particular interest are the measurements for meteors which are also observed visually. The results show that the density in the trail of a 5th-magnitude meteor (on the limit of naked eye visibility) is approximately 2×10^{10} electrons/cm path. Brighter meteors ($\sim$ magnitude + 1) produce 10^{12} electrons/cm path. These results are in good agreement with theoretical calculations. The theory is compared with earlier calculations. A.

523.75 2310

Recent advances in science. Astronomy. HUNTER, A. *Sci. Progr.*, **36**, 262–8 (*April*, 1948).—Subject: Chromospheric flares (7 refs.).

523.76 2311

The abundance of oxygen in the sun. BOWEN, I. S. *Rev. Mod. Phys.*, **20**, 109–12 (*Jan.*, 1948).—Forbidden lines of neutral oxygen (5 577, 6 300, 6 363 Å) were photographed in the sun's spectrum at Mount Wilson, and used to calculate the number of O atoms in the reversing layer as 7×10^{20}/cm^3, and an excitation temperature of 5 200°. Similar calculations of the abundance of other light elements (e.g. C, N, Si, S), are suggested. A. B.

523.77 : 535.33 2312

The ultraviolet spectrum of the sun from V-2 rockets. HOPFIELD, J. J., AND CLEARMAN, H. E., JR. *Phys. Rev.*, **73**, 877–84 (*April* 15, 1948).—Spectra were obtained from V-2 rockets at heights up to 155 km. A grating spectrograph was used giving a dispersion of 34 Å/mm. The u.v. spectrum obtained extends down to λ2300 Å, and traces are evident as far as λ2230 Å. A tentative list of identified lines is given. The Mg II resonance doublet at λ2800 Å is observed to have emission centres in both absorption components. The intensity of this emission is estimated as $\sim$10% that of the adjacent continuum. A.

523.841.11 : 539.17 : 523.11 = 3 *see Abstr.* 2307

523.877 = 3 2313

On the integral equation of radiative equilibrium in stellar atmospheres. UNSÖLD, A. *Z. Astrophys.*, **24** (*Nos* 3–4) 363–83 (1948) *In German.*—The physical significance of Hopf's solution by successive approximations for a grey atmosphere is discussed, and the method is extended to the case in which the absorption coefficient is a function of frequency and depth. A generalization of the method to allow for scattering is also considered. R. A. N.

523.877 : 531.19 : 537.56 = 3 *see Abstr.* 2491

525.35 : 531.382 2314

On the dynamical theory of the rotation of the earth. I. The secular retardation of the core. BONDI, H., AND LYTTLETON, R. A. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 345–59 (1948).—Questions raised by the assumption that the earth does not rotate as a rigid or slightly deformable body, and that the motion, at any instant, cannot be represented by a single angular velocity, are examined. The simplest form of the secular problem is that of the motion of a uniform viscous liquid bounded by a rigid spherical surface whose angular velocity changes slowly. The equations of motion are obtained, linearized, and then solved. The conclusion is that the tidal friction couple may be considered as if it were applied to the earth as a whole, regarded as a rigid body, and the original treatment of the secular acceleration needs no serious revision. The 2-dimensional (cylindrical) problem is also considered. L. S. G.

525.37 : 531.114 : 591.185.63 *see Abstr.* 2634

526.918.5 : 535.317 : 535.8 *see Abstr.* 2427

PHYSICS 53

53 : 016 = 3 2315

In memory of Max Planck. MEISSNER, W. *Z. Naturforsch.*, **2a**, 587–95 (*Oct.*, 1947) *In German.*—A short biography, and list of 219 of his publications.

53.081.5 : 621.3.011 = 4 2316

On the electromagnetic system of units. BRYLINSKI, E. *C.R. Acad. Sci., Paris*, **226**, 68–9 (*Jan.* 5, 1948) *In French.*—The e.m. c.g.s. units are derived from I_m, the unit of current obtained from the consideration of the force between two infinitely long parallel currents i at a distance r in a medium of magnetic permeability μ, for which the force on a length l of the one conductor is $f = 2\mu i^2 l/r$. Putting $l = r$ and $\mu = 1$, $f = 2i^2$, and the force for unit current I_m is 2 dynes, and $I_m = 10$ amperes in agreement with the original definition of the ampere. The units are tabulated. H. G. S.

53.081.6 : 539.15 *see Abstr.* 2515

53.087.6 : 534.647 2317

On the record registered on a cylinder with uniform screw motion. PENDSE, C. G. *Phil. Mag.*, **39**, 471–6 (*June*, 1948).—A study is made of the relation between the radius and translatory and rotational speeds of the recording cylinder of a seismograph, and the appearance of the record when the chart is flattened out. A conformal transformation for the flattening of the surface of the cylinder into a plane is given. The effects of sudden changes in the screw motion on the appearance of the records are briefly discussed. L. S. G.

FUNDAMENTALS 530.1

530.12 : 523.11 *see Abstr.* 2308

530.12 : 530.14 = 4 2318

The Lorentz transformation and particle waves. SLANSKY, S. *C.R. Acad. Sci., Paris*, **226**, 389–90 (*Feb.* 2, 1948) *In French.*—A simple derivation of the Lorentz transformation is obtained from the transformation properties of a plane wave for a particle. The constant c appears as a constant in the relation between energy and frequency. G. J. K.

530.12 : 531.51 2319

The question of non-singular solutions in the generalized theory of gravitation. PAPAPETROU, A. *Phys. Rev.*, **73**, 1105–8 (*May* 1, 1948).—In the relativistic theory of gravitation the field equations do not admit any non-singular static solution representing a field of non-vanishing total mass. It is shown that this theorem is valid in the generalized theory of gravitation with non-symmetric g_{ik}. A.

530.12 : 538 2320

On magnetism of celestial bodies. MARIANI, J. *Phys. Rev.*, **73**, 78–9 (*Jan.* 1, 1948).—The magnetism of rotating bodies is considered in terms of general relativity; assuming electromagnetism and rotation are uniquely associated, a magnetism of cosmic bodies of the right order of magnitude is obtained. W. E. D.

530.12 : 538 2321

Magnetic field of massive rotating bodies. PIAGGIO, H. T. H. *Nature, Lond.*, **161**, 450 (*March* 20, 1948).—A very short review is made of the recent theory of Mariani [see, e.g., Abstr. 2320 (1948)] and a list of his publications is given.

530.14 2322

Problems of elementary particle physics. BOHR, N. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 1–4 (1948).—Brief review.

530.14 2323

Relativistic quantum mechanics and the principle of reciprocity. BORN, M. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 14–21 (1948).—The idea of reciprocity [Abstr. 2028 (1940)] is clarified and reinforced by recent work by Heisenberg on the S-matrix. G. J. K.

530.14 2324

New possible equations for fundamental particles. PROCA, A. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 180–1 (1948).—Alternative relativistic forms of the Dirac equations are suggested in terms of two spinors only, from which the usual space-time co-ordinates are derived. G. J. K.

530.14 2325

On the theory of the characteristic matrix. MØLLER, C. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 194–9 (1948).—A summary of the S-matrix theory of Heisenberg and its extension in recent papers. G. J. K.

530.14 2326

The present state of the S-operator theory. STÜCKELBERG, E. C. G. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 199–200 (1948).—A short review of the author's recent work (bibl.) G. J. K.

530.14 2327

Interaction of mesons with a potential field. GUNN, J. C. *Proc. Roy. Soc. A*, **193**, 559–79 (*July* 21, 1948).—The Takata–Saketani wave equation for mesons [Abstr. 188 (1941)] is developed to allow the solution of a variety of problems concerning the behaviour of charged vector mesons in an electrostatic field. The form of the radial wave equations is discussed. The general elastic scattering problem is formulated, and the Born approximation for the phases is discussed for the Coulomb field, for which no exact solution is possible. The exact treatment of scattering by a spherical well is considered. This is the only case for which exact treatment in terms of known functions seems practicable, and might be of service in indicating the limits of the validity of approximate processes in other cases. A.

530.14 = 4 2328

Relativistic equations for elementary particles. PROCA, A. *C.R. Acad. Sci., Paris*, **223**, 270–2 (*Aug.* 5, 1946) *In French.*—Equations of the form $M\psi = 0$ are considered where the operator M is a spinor, rather than a tensor as is usual. Two examples are given, one of which is an extension of Dirac's equation. L. S. G.

530.14 : 530.12 = 4 *see Abstr.* 2318

530.14 : 539.152.1 2329

The conservation of energy, momentum and charge in the nuclear field. FLINT, H. T., AND SYMONDS, N. *Phil. Mag.*, **39**, 413–19 (*June*, 1948).—Previous work is continued [Abstr. 33 (1948)]. The discussion is limited to a scalar field and is based on a modified Dirac equation. The energy tensor is formulated and its conservation is demonstrated. L. S. G.

530.14 : 539.152.1 : 537.133 2330

The quantum theory of damping as a proposal for Heisenberg's S-matrix. HEITLER, W. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 189–94 (1948).—The isobaric states of a nucleon are obtained, using the Heitler–Hamilton radiation damping theory linked with the S-matrix [Abstr. 227 (1948)]. G. J. K.

530.145 2331

Difficulties of field theories and of field quantisation. PAULI, W. *Rep. Internat. Conf. "Fundamental particles"* (1946) (*Phys. Soc., Lond.*) **1**, 5–10 (1948).—A review of methods already proposed to eliminate infinities from the theory includes the derivation by wave mechanics of a relatively simple expression $S = (1 - i\pi K)/(1 + i\pi K)$ for the Heisenberg S-matrix, where K is derived from the Hamiltonian. G. J. K.

530.145 2332

Relativistic wave equations for the elementary particles. BHABHA, H. J. *Rep. Internat. Conf. "Fundamental particles"* (1946) (*Phys. Soc., Lond.*) **1**, 22–36 (1948).—A scheme of relativistic equations for elementary particles of any integral or half-odd integral spin, is given. On this scheme all elementary particles except those of spin, 0, $\frac{1}{2}$ and 1 must appear with several values of the rest mass which bear well defined and simple numerical ratios to the lowest value. The analysis of the structure of the equations and the associated wave-functions is carried further than in the previous papers. The theory can be quantized with mathematical rigour, even in the presence of interaction, but this quantization requires a special prescription for interpreting the formalism physically. A.

530.145 : 539.132 2333

Quantum mechanics of the anharmonic oscillator. MCWEENY, R., AND COULSON, C. A. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 413–22 (1948).—A method is described for the accurate numerical treatment of molecular vibration problems where the potential energy function is

$$V(x) = ax + bx^2 + cx^3 + dx^4 + \ldots,$$

and the details are given for the case $V(x) = Ax^2 + Bx^4$. Approx. formulae for the energy levels are given, and for the case $V = ax^4$ the first 5 eigen-values and eigen-functions are computed and then the transition probabilities. A simple ground-state wave-function is found for 4th-power vibrations. This is based on an asymptotic solution of the wave-equation. L. S. G.

530.145 2334

On the occurrence of detailed balancing in quantum mechanics. LANDSBERG, P. T. *Phil. Mag.*, **38**, 824–8 (*Nov.*, 1947).—The observables of quantum theory are represented in a linear associative algebra defined over the field of complex numbers. Some properties of this algebra are developed, and it is shown that the principle of detailed balancing is a corollary of Temple's assumption of the existence of transition probabilities. L. S. G.

530.145 2335

On the calculation of self-energies in quantum theory by analytic continuation. NILSSON, S. B. *Phys. Rev.*, **73**, 903–9 (*April* 15, 1948).—It is shown that the general result of Gustafson's procedure [Abstr. 1729 (1947)] is to remove all divergences normally appearing in self-energy expressions, except logarithmic divergences. Thus the total self-energy of the electron, to the second approximation, is found to be zero on the one-electron theory if calculated by this method, whereas in the whole theory the logarithmically divergent expression of Weisskopf is retained. A proposal by Pauli to alter the commutation rules in a certain way gives essentially the same results. A.

530.145 2336

On the formal extension of Dirac's equation under continuous transformation groups. HILL, E. L. *Phys. Rev.*, **73**, 910–15 (*April* 15, 1948).—The theory of equations of the Dirac type which are form-invariant under general finite continuous groups of point transformations in space-time is developed. The possible equations invariant under a given group depend on the structure of the group, but in each case the required invariance imposes a set of linear homogeneous relations on the β-operators with which any assumed algebra must be consistent. It is shown that the algebra appropriate to the general equation possessing form-invariance under the inhomogeneous Lorentz group is necessarily of infinite order. A.

530.145 2337

Trajectories of charged meson test particles in the similarity geometry. HOFFMANN, B. *Phys. Rev.*, **73**, 1042–6 (*May* 1, 1948).—For previous work see Abstr. 1150 (1948), 3417 (1947). It is shown that there is a close relationship between the hitherto distinct theories of Weyl and Kaluza. Simple equations belonging to the similarity geometry are found to give the correct trajectories for charged meson test particles. A.

530.145 = 4 2338

Application of the quantum characteristic function to the study of the harmonic oscillator. D'ESPAGNAT, B. *C.R. Acad. Sci., Paris*, **226**, 316–18 (*Jan.* 26, 1948) *In French.*

530.145 : 535.14 2339

A note on M. de Broglie's theory of the photon. WILLIAMSON, M. *Phil. Mag.*, **39**, 314–24 (*April*, 1948).—De Broglie suggests that the photon may be composed of two "demi-photons," each with spin $\frac{1}{2}h/2\pi$. It is now shown that a simpler theory is possible, in which the photon is a single particle with a vanishingly small mass. It is described by the Dirac equation, where the wave function has 16 components. The Hamilton operator, the momentum operators and the spin for the photon are discussed. L. S. G.

530.145 : 535.14 2340

Radiation damping and velocity of light. HEITLER, W. *Nature, Lond.*, **161**, 678–9 (*May* 1, 1948).—Criticism and discussion of the letter by Ferretti and Peierls [Abstr. 228 (1948)].

530.145 : 537.122 2341

On an exact solution of Dirac electron in the field of electromagnetic radiation. SENGUPTA, N. D. *Bull. Calcutta Math. Soc.*, **39**, 147–53 (*Dec.*, 1947).—The exact solution is obtained. It is similar to that of Volkov [Abstr. 2854 (1935)]; the 4-dimensional generalization of Volkov's solution follows easily, and the solution can be extended to the case where the radiation field is not monochromatic. L. S. G.

530.145 : 537.122 = 4 2342

On the first integrals in Dirac's electron theory. PETIAU, G. *C.R. Acad. Sci., Paris*, **223**, 269–70 (*Aug.* 5, 1946) *In French.*—Dirac's equation is written down and its first integrals are constructed. If an external field is now introduced, it is noted that these quantities are no longer first integrals. Their variation with time is calculated. L. S. G.

530.145 : 537.122 = 4 2343

On the Lorentz force and the spin force in the Dirac electron theory. PETIAU, G. *C.R. Acad. Sci., Paris*, **226**, 313–14 (*Jan.* 26, 1948) *In French.*

530.145 : 537.591 2344

The possible existence of mass spectra of fundamental particles. MØLLER, C. *Rep. Internat. Conf. "Fundamental particles"* (1946) (*Phys. Soc., Lond.*) **1**, 184 (1948).—A mass-spectrum, predicted by a 5-dimensional meson theory, is discussed in relation to data on the decay constants and masses of particles in hard cosmic rays. G. J. K.

530.145 : 538.3 2345

The difficulties in quantum electrodynamics. DIRAC, P. A. M. *Rep. Internat. Conf. "Fundamental particles"* (1946) (*Phys. Soc., Lond.*) **1**, 10–14 (1948).—It is argued

that these difficulties disappear if a suitable representation of the theory is used and that they are therefore mathematical rather than physical. G. J. K.

530.145 : 539.152.1 *see Abstr.* 2519–20

530.145 : 539.18 *see Abstr.* 2583

530.145 : 539.185 *see Abstr.* 2589

530.145.1 2346

On Dirac's theory of continuous spectra. WINTNER, A. *Phys. Rev.*, **73**, 781–5 (*April* 1, 1948).—By an heuristic application of the group generated, in a formal sense, by the quantum-mechanical rule of commutation, Dirac arrived at the following result: The group property "propagates" an eigenvalue, discrete or continuous, in such a way as to compel its emergence at any preassigned eigenvalue. This result is modified and proved. The proof, carried out only for the case of wave equations of radial symmetry, depends on the completeness of the orthogonal system formed by the eigenfunctions and eigendifferentials together. A.

530.145.1 2347

Quantum theory of localizable dynamical systems. DIRAC, P. A. M. *Phys. Rev.*, **73**, 1092–103 (*May* 1, 1948).—A dynamical system is localizable if its wave functions can be expressed in terms of variables, each referring to physical conditions at only one point in space-time. These variables may be at points on any three-dimensional space-like surface in space-time. A general investigation is made of how the wave function varies when the surface is varied in any way. The variation of the wave function is given by equations of the Schrödinger type involving certain operators $H^n(u)$ which play the role of Hamiltonians. The commutation relations for these operators are obtained. The theory works entirely with relativistic concepts and it provides the general pattern which any relativistic quantum theory must conform to, provided the dynamical system is localizable. A.

530.145.1 : 538.3 2348

A generalization of the method of separating longitudinal and transverse waves in electrodynamics. ASHAUER, S. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 206–17 (1948).—The method consists in splitting up each Fourier-component of the wave-field 4-vector with respect to two null-vectors $\mathbf{k}$ and $\mathbf{l_k}$, where $\mathbf{k}$ is the Fourier vector of propagation, and $\mathbf{l_k}$ is an arbitrary (real) function of $\mathbf{k}$ satisfying $(\mathbf{l_k}, \mathbf{k}) = 1$ and $\mathbf{l}_{-\mathbf{k}} = -\mathbf{l_k}$. This amounts to referring each Fourier-component of the field to a different time-axis in the usual method of splitting up. $\mathbf{l_k}$ may also depend on the co-ordinates of the particles of the system. The longitudinal field variables are eliminated from the Hamiltonian formulation of electrodynamics by a contact transformation; the term which then replaces the longitudinal field depends on the co-ordinates of the particles, and in general also on the transverse field variables, except when $\mathbf{l_k}$ is independent of the co-ordinates of the particles. The work holds both in the classical and in the quantum theory. For the problem of an electron moving in the field of a nucleus a particular form is chosen for the $\mathbf{l_k}$, which depends on the initial velocities of both the particles. The new longitudinal waves are eliminated, and the classical deflexion formula is derived on the assumption that the interaction with the new transverse waves can be neglected. The new method leads to half the deflection derived by the usual method of working only with the Coulomb interaction force (and so neglecting radiation damping in a certain way), when the nuclear recoil is neglected and the deflection angle is small. For a low-velocity electron, the effect of the new transverse waves cannot be small, but for a very high energy electron the new method may be more suitable than the usual one. A.

530.145.6 2349

Equations for particles of higher spin. HARISH-CHANDRA. *Rep. Internat. Conf. "Fundamental particles"* (1946) (*Phys. Soc., Lond.*) **1**, 185–8 (1948).—The theory of elementary particles based on a linear wave equation with matrix coefficients is developed. The physical assumptions regarding such a particle are translated into algebraic restrictions on these coefficient matrices. The theory is then illustrated by considering a special case, which corresponds to a particle with spin values $\frac{1}{2}$ and $\frac{3}{2}$. A.

530.145.6 = 4 2350

On a meson theory with many mass values. POTIER, R. *C.R. Acad. Sci., Paris*, **226**, 314–16 (*Jan.* 26, 1948) *In French.*—Selection rules are given for transitions between states of different mass value. G. J. K.

530.145.6 : 537.533.1 2351

Electronic waves and Thibaud's "particles." BENHAM, W. E. *Nature, Lond.*, **161**, 93 (*Jan.* 17, 1948).—An earlier letter is corrected [Abstr. 2779 (1947)]. The energy radiated or absorbed from beams of electrons or heavier particles is negligibly small; but for very light particles Thibaud's "electrinos" [Abstr. 1640 (1948)] the radiation rate/kinetic energy ratio might be very large, and the radiation observable.

530.145.6 : 539.152.1 *see Abstr.* 2521

530.145.6 : 539.18 = 4 2352

On the Lorentz force and spin interaction in the theory of the meson. PETIAU, G. *C.R. Acad. Sci., Paris*, **226**, 387–8 (*Feb.* 2, 1948) *In French.*—The time-variation of the expectation value of the momentum is derived from the particle equations of the meson, by analogy with the electron, to make explicit the Lorentz force and spin interaction of a meson in an electromagnetic field. G. J. K.

530.162 : 534.756 *see Abstr.* 2403

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.112.2 : 621.831 2353

Vectorial theory of gear wheel tooth profiles. ZWIKKER, C. *Appl. Sci. Res.*, **A 1** (*No.* 2) 139–50 (1948).

531.114 : 525.37 : 591.185.63 *see Abstr.* 2634

531.19 : 523.877 : 537.56 = 3 *see Abstr.* 2491

531.224 : 625.14 2354

On the dynamic behaviour of an elastically supported beam of infinite length, loaded by a concentrated force. ESMEIJER, W. L. *Appl. Sci. Res.*, **A 1** (*No.* 2) 151–68 (1948).—General expressions are given for the deflection and the bending moment. Three special cases are considered. The results given may be of use in railway-engineering problems. A.

531.224.4 : 532.224.4 2355

Note on the buckling of a vertically submerged tube. BIEZENO, C. B., AND KOCH, J. J. *Appl. Sci. Res.*, **A 1** (*No.* 2) 131–8 (1948).—It is proved that no buckling of a vertically submerged tube occurs under its own weight. A.

531.25 : 517.6 2356

The method of the hypercircle in elasticity when body forces are present. SYNGE, J. L. *Quart. Appl. Math.*, **6**, 15–19 (*April*, 1948).—A restriction in previous work [Abstr. 211 (1948)] is removed, and the method in complete form is given. L. S. G.

531.252 : 517.65 *see Abstr.* 2293

531.382 : 525.35 *see Abstr.* 2314

531.391.1 = 4 2357

Limits to the variation of the tension in a lifting cable. NÉRONOFF, N. P. *C.R. Acad. Sci. URSS*, **54** (*No.* 4) 301–4 (1946) *In French.*—A heavy cage is attached to the end of a long cable which runs on a smooth pulley. Expressions are found for the max. and min. tension in the cable, assuming it obeys Hooke's law, in the cases of uniform and uniformly accelerated motion. A numerical example is given. L. S. G.

531.45 2358

Rate of wear in the region of the validity of Amontons' law. BEZER, H. J., AND SCHNURMANN, R. *Nature, Lond.*, **161,** 728 (*May* 8, 1948).—Measurements are recorded of the radius of the final wear prints of a revolving steel ball loaded against a metal plate. The loads ranged up to 15 kgm. Frictional torque measurements were also made, and the functional dependence of the torque on the load was determined. L. S. G.

531.51 : 530.12 *see Abstr.* 2319

MECHANICAL MEASUREMENTS 531.7

531.7 + 535.8 + 536.5/.6 2359

Mechanical, thermal and optical instruments shown at the Physical Society's exhibition. PEACOCK, A. G. *J. Sci. Instrum. Phys. Ind.*, **25,** 178–81 (*June*, 1948).

531.7 : 621.317.39 2360

Some applications of electronics in metrology. WILLEY, E. J. B. *Sci. Progr.*, **36,** 55–65 (*Jan.*, 1948).—A short review article. Electrical gauges, surface meters, vibration and acceleration meters, strain gauges and ultrasonic thickness meters and flaw detectors are touched on. (4 diagrams, 18 references.)

531.714 = 3 2361

Pneumatic length measurement principles. GÖTHEL, E. *Arch. tech. Messen, Issue* 152 (*Ref. V*1121–6) *T*3 (*July*, 1947) *In German.*—The "Solex" pneumatic method of length measurement, invented by Marcel Menneson, gives an accurate indication of small length differences by using gas flow. Constant-pressure compressed air flows through an orifice into a closed chamber and through a second orifice, where it impinges on a surface at distance d. The pressure in the closed chamber then $\propto d$. The incoming air pressure is kept constant by an air-bubble overflow and the chamber pressure is measured by a water manometer. The theoretical air flow relations are deduced. Owing to moisture and orifice-bore roughness these relations are very approximate, and the instrument must be empirically calibrated. V. W. R.

MECHANICS OF LIQUIDS 532

532.12 : 534.321.9 2362

Mechanical properties of long chain molecule liquids at ultrasonic frequencies. MASON, W. P., BAKER, W. O., MCSKIMIN, H. J., AND HEISS, J. H. *Phys. Rev.*, **73,** 1074–91 (*May* 1, 1948).—Measurements of the mechanical properties were made by shear and longitudinal waves. The shear waves show that these liquids behave as Maxwell relaxing liquids. The viscosity measurements in the range around 14 kc/s check the viscosities measured by falling ball measurements within the experimental error. As the temperature decreases or the frequency increases, the reaction of the liquid shows that a shear elasticity of the Maxwell type comes into play with a shear elastic constant of from 5×10^6 dynes/cm^2 to 5×10^7. This elasticity increases with decreasing temperature and increases with chain length, and represents an intermediate type to the "frozen" type of elasticity or the "kinetic theory" type in that it has the high compliance of the "kinetic theory" type but the temperature variation of the "frozen" type of elasticity. Above about 30 kc/s, some shear viscosity is relaxed by the shear elasticity. Measurements with longitudinal ultrasonic waves show a dispersion of velocity and an associated attenuation curve. From very low frequencies to very high frequencies the velocity increases by ~25%, while the attenuation has the high value of 0·7 neper per wavelength at a frequency for which the velocity is a mean between the two extremes. A relaxation occurs in the shear elasticity. The measured attenuation frequency curve is broader than that of a single relaxation frequency and indicates that the attenuation reaches a constant value per wavelength at high frequencies. A simple explanation of this is that the rearrangement compliance has a hysteresis component. Calculations of the velocity and attenuation on this basis agree very well with the measured curves. A.

532.13 2363

Determination of the viscosity of molten salts by a capillary method. The system cadmium chloride-cadmium bromide. BLOOM, H., HARRAP, B. S., AND HEYMANN, E. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 237–44 (1948).

532.13 : 537.36 2364

Electroviscosity. I. The flow of liquids between surfaces in close proximity. ELTON, G. A. H. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 259–74 (1948).—The conditions governing the rate of flow of ionic and non-ionic liquids in narrow channels are examined, and it is shown that in certain circumstances the electrical resistance to shear in ionic liquids, due to the effect of an electrical potential gradient on the ions of the surface layers, may assume considerable importance relative to the mechanical (viscous) resistance to shear. The results of this analysis are of important application in various fields, and offer an explanation of anomalous results obtained by numerous experimental workers. A.

532.13 : 537.36 2365

Electroviscosity. II. Experimental demonstration of the electroviscous effect. ELTON, G. A. H. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 275–87 (1948).—Preliminary experimental evidence for the existence of the effect in ionic liquids is submitted. The theoretical predictions [Abstr. 2364 (1948)] have been qualitatively confirmed. The rate of approach of surfaces in various liquids has been observed, and it has been demonstrated that equilibrium distances of separation under finite pressures are very small. A.

532.224.4 : 531.224.4 *see Abstr.* 2355

532.5 2366

The breakdown of the hodograph transformation for irrotational compressible fluid flow in two dimensions. CRAGGS, J. W. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 360–79 (1948).

532.517.2 2367

Concerning the effect of compressibility on laminar boundary layers and their separation. HOWARTH, L. *Proc. Roy. Soc. A*, **194,** 16–42 (*July* 28, 1948).—The theory of compressible flow in a laminar boundary layer is developed for the case when the viscosity is assumed to be proportional to the absolute temperature and the Prandtl number is unity. Several particular solutions are considered, including accelerated flow with a linearly increasing velocity and retarded flow along a flat plate with a linearly decreasing velocity. A.

532.517.2 2368

The laminar boundary-layer equations of bodies of revolution. Motion of a sphere. MEKSYN, D. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 218–28 (1948).—A continuation of previous work [Abstr. 1159–60 (1948)]. The general boundary-layer equations are derived for axially symmetrical motions of bodies of revolution; the equations are partially solved for a sphere, and the results compared with experimental measurements. A.

532.517.4 2369

Decay of isotropic turbulence in the initial period. BATCHELOR, G. K., AND TOWNSEND, A. A. *Proc. Roy. Soc. A*, **193**, 539–58 (*July* 21, 1948).—A continuation of previous work [Abstr. 542 (1948)].

532.535 2370

An investigation of the energy dissipated in a surface roller. OOSTERHOLT, G. A. *Appl. Sci. Res.*, **A 1** (*No.* 2) 107–30 (1948).—Theory of the dissipation in hydraulic jumps. It is important in connection with flow phenomena along weirs, sluice-gates, etc. A.

532.582 = 4 2371

Immersion of a cylinder in a viscous medium filling a vessel of axial symmetry. TARG, S. M. *C.R. Acad. Sci. URSS*, **54** (*No.* 4) 305–8 (1946) *In French.*—The cylinder is immersed end-on, with constant velocity, and equations are written down for the resulting motion of the viscous fluid. An expression is derived for the resulting force acting on the end of the cylinder and this is approximated in the cases where the vessel is a cylinder or a cone.

L. S. G.

CAPILLARITY 532.6

532.6 : 541.182.2 : 551.578.11 2372

The spraying of liquids from aircraft. RICHARDSON, E. G. *Sci. Progr.*, **36**, 206–13 (*April*, 1948).—A short review, directing attention to the problems of initial and final drop size, instability and evaporation during fall, and optimum size for different purposes of the spray.

532.6.08 2373

A new drop-weight method for the comparison of surface tensions. BROWN, R. C., AND MCCORMICK, H. *Phil. Mag.*, **39**, 420–8 (*June*, 1948).—An investigation is made, by dimensional analysis, of the correction factor in the method of Harkness and Brown [*J. Amer. Chem. Soc.*, **41**, 499 (1919)]. In the new method, the usual flat tip of the former method is replaced by an inverted cone. Theory shows that all unstable drops hanging from such a cone are similar in shape, and surface-tension measurements may be made once the cone is calibrated by means of a liquid of known surface tension. The new method involves no correction factor. L. S. G.

532.61.08 2374

On the calculation of surface tension from measurements of pendant drops. FORDHAM, S. *Proc. Roy. Soc. A*, **194**, 1–16 (*July* 28, 1948).—The calculations give the shapes of pendant drops of liquids for values of β from $-0{\cdot}25$ to $-0{\cdot}6$ at intervals of $0{\cdot}025$. Here, $\beta = -g\sigma b^2/\gamma$, where σ is the density of the liquid, γ is the surface tension and b is the radius of curvature of the drop at the lowest point. The results were used to calculate, to an accuracy of $0{\cdot}001$ to $0{\cdot}01\%$, the constants needed for measuring surface and interfacial tensions by the method suggested by Andreas, Hauser and Tucker [Abstr. 126 (1939)], which has thus been made independent of calibration. A.

KINETIC THEORY OF LIQUIDS 532.7

532.7 : 536.48 2375

A general kinetic theory of liquids. V. Liquid He II. GREEN, H. S. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 244–58 (1948).—See Abstr. 3435 (1947). An examination of the detailed application of the general quantum theory of fluids to liquid He II. It is shown that although the classical laws of hydrodynamics and thermodynamics are formally obeyed by the quantum liquid, important divergencies arise in the manner of their interpretation. Without introducing any assumption other than the validity of the general laws of quantum mechanics, it is possible to explain qualitatively and quantitatively the well-known properties of liquid helium, including the thermodynamic discontinuity, the thermomechanical effect, the transfer effect, and the presence of thermal waves in the liquid. The connection with earlier theories is traced, and it is shown that although they are in agreement with the theory here proposed in certain respects, their fundamental concepts are in need of considerable revision. The theory can be applied with slight changes to the phenomenon of superconductivity. A.

MECHANICS OF GASES 533

533.15 2376

On gaseous self-diffusion in long capillary tubes. POLLARD, W. G., AND PRESENT, R. D. *Phys. Rev.*, **73**, 762–74 (*April* 1, 1948).—The rate of diffusion of "tagged" molecules in a pure gas at uniform pressure in a long capillary tube of half-length L and radius a was made. At pressures for which the mean free path $\lambda \gg a$, the result in the limit $L \to \infty$ reduces to that obtained by Knudsen, the diffusion coefficient D being given by $2a\bar{v}/3$, where $\bar{v}$ is the mean molecular speed. For a capillary of finite length the diffusion coefficient is, to first order in a/L, smaller than this by a factor $1 - 3a/4L$. In the opposite limit of high pressures, for which $\lambda \ll a$, the result reduces to the elementary kinetic theory expression for the self-diffusion coefficient, $D = \lambda\bar{v}/3$. One of the most significant features of the result is that in a long tube the diffusion coefficient drops very rapidly with increasing pressure from its initial value for $\lambda \gg L$. Thus the initial slope of D as a function of pressure is given by $dD/d(a/\lambda) \simeq -\frac{1}{2}\bar{v}a \ln L/a$. It is shown that these results account for the anomalous low pressure minima observed by several investigators who have measured the specific flow, $G/\Delta p$, through long capillary tubes as a function of mean pressure $\bar{p}$. The failure to observe such minima with porous media, for which effectively $L \simeq a$ in each pore, is also explained by these results. The formulae obtained here represent a rigorous solution to the long capillary diffusion problem, valid at all pressures and subject only to the limitations of the mean-free-path type of treatment.

533.24 : 536.483 2377

A quantitative study of the expansion method for liquefying helium. PICKARD, G. L., AND SIMON, F. E. *Proc. Phys. Soc., Lond.*, **60**, 405–13 (*May*, 1948).—The yield was measured for various starting conditions and the results are presented in the form of two diagrams. Some preliminary data are given on the volumes and specific heats of compressed helium gas; they give all the information necessary for the design of an expansion liquefier. The entropy diagram was extended to higher pressures and the actual yield compared with the ideal yield of a piston and cylinder arrangement. The simple expansion method results in an efficiency which is 60% of the ideal when starting from the usual temperature and pressure conditions. The reasons for this high efficiency are discussed. A.

533.24 : 536.483 2378

The liquid hydrogen plant at the Clarendon Laboratory, Oxford. JONES, G. O., LARSEN, A. H., AND SIMON, F. E. *Research, Lond.*, **1**, 420–32 (*June*, 1948).—A description is given of the recently erected plant. The design of the liquefier itself, which is of the Linde type and produces 13 litres per hour, is explained in some detail, since it incorporates many novel features. Special attention has been given to questions connected with the reliable and smooth running of the plant. A.

533.275 2379

Measurement of water in gases by electrical conduction in a film of hygroscopic material and the use of pressure changes in calibration. WEAVER, E. R., AND RILEY, R. *J. Res. Nat. Bur. Stand., Wash.*, **40**, 169–214 (*March*, 1948).—The electrical conductivity of a thin film of a material such as phosphoric acid changes over a wide range with changes in the concentration of water in the atmosphere with which it is in contact. By adjusting the pressures of a sample of gas of known and one of unknown composition, they can be made to have the same concentration of water, shown by the production of equal resistances of the detecting film. Apparatus and procedures for making such adjustments and calculating analyses are given in detail, and numerous applications are described. The method has the merits of simplicity, speed, and great sensitivity. Only small samples are needed, and few substances interfere. A.

533.5 2380

A leak protection circuit for vacuum systems. LEWIS, I. A. D., AND CHIPPINDALE, P. *J. Sci. Instrum. Phys. Ind.*, **25**, 205–6 (*June*, 1948).—Circuit diagram and component values are given of a valve relay circuit operated from a Pirani gauge to switch off oil pumps in the event of pressure rise.

533.5 2381

Vacuum protection system for oil diffusion pumps and thermionic filaments. ALLWOOD, H. I. S. *J. Sci. Instrum. Phys. Ind.*, **25**, 207–8 (*June*, 1948).—A special discharge tube controls relays operating diffusion pump heaters at a critical pressure of 10^{-1} mm Hg, and an ionization gauge similarly protects filaments in the ion source, etc., at 10^{-3} mm. Diagrams of discharge tube and ionization gauge are given, and operating characteristics.

533.5 + 621.38 2382

Electronic and vacuum physics apparatus at the Physical Society's Exhibition. RYMER, T. B. *J. Sci. Instrum. Phys. Ind.*, **25**, 183–4 (*June*, 1948).

533.56 2383

An uncooled all-metal oil diffusion pump. LIEBMANN, G. *J. Sci. Instrum. Phys. Ind.*, **25**, 186–7 (*June*, 1948).—The design and performance of the pump is described. Direct heat transfer from the boiler chamber to the condenser is reduced to a negligible amount, and the required cooling is provided by natural convection. The pumping speed at a heater input of 100 W is 8 l./sec. A.

533.6 : 534.01 *see Abstr.* 2385

533.6.011.5 2384

The propagation of steady disturbances in a supersonic stream bounded on one side by a parallel subsonic stream. HOWARTH, L. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 380–90 (1948).

KINETIC THEORY OF GASES 533.7

VIBRATIONS . ACOUSTICS 534

534.01 : 533.6 2385

Acoustical methods in supersonic aerodynamics. MILES, J. W. *J. Acoust. Soc. Amer.*, **20**, 314–23 (*May*, 1948).—Certain theoretical techniques common to acoustics and supersonic aerodynamics are discussed. The basic equations describing hydrodynamical phenomena taking place in a supersonic, inviscid stream are developed. After linearization, the equations are solved for the velocity potential resulting from an arbitrary source distribution in the plane $z = 0$. The integration of the results for two-dimensional flow is carried out, and the application to various aerodynamic problems is cited. As a second illustration, an analogy between two-dimensional flow caused by a distribution of acoustic oscillators along a line having arbitrary time histories and the steady three-dimensional flow about a thin wing is described. Using the techniques of Fourier integrals, this analogy is used to compute the wave drag caused by a symmetrical wing at zero lift. A.

534.1 2386

Vibration of a nonlinear system during acceleration through resonance. MEUSER, R. B., AND WEIBEL, E. E. *J. Appl. Mech.*, **15**, 21–4 (*March*, 1948).—During acceleration of a machine through a critical speed, displacements and stresses may attain large values. The paper presents a generalized solution obtained on the mechanical analyser for the effect of an accelerated sine-wave force on a spring-mass system having linear plus cubic elasticity and linear damping. The range of accelerations covered applies to electrically driven reciprocating machines and to other rapid starting units. Some interesting effects of non-linearity on displacements and forces are pointed out. A.

534.141.2 2387

Elastic impact of pianoforte hammer. GHOSH, R. N. *J. Acoust. Soc. Amer.*, **20**, 324–8 (*May*, 1948).—The dynamical theory of the impact of a felt hammer upon a string at a distance α from one fixed end, such that the reflected wave from the other distant fixed end does not reach the striking point during the time the hammer is in contact with the string, is discussed. An operational method leads to a solution in the form of a series consisting of incommensurable terms with damping coefficients increasing with the order of the term and tending to a limiting value. In the case of a hard hammer the damping coefficients decrease, and the terms are very much less incommensurable. These are the essential differences between the two cases that lead to smoothing down of the pressure and time curve between the hammer and the string in the case of a felt hammer. A.

534.213 2388

Errata: The propagation of an acoustic wave along a boundary. RUDNICK, I. *J. Acoust. Soc. Amer.*, **20**, 149 (*March*, 1948).—See Abstr. 2437 (1947).

534.222.2 2389

Secondary pressure pulses due to gas globe oscillation in underwater explosions. I. Experimental data. ARONS, A. B., SLIFKO, J. P., AND CARTER, A. *J. Acoust. Soc. Amer.*, **20**, 271–6 (*May*, 1948).—Pressure waves emitted by the oscillating gas globe in underwater explosions of T.N.T. were recorded at depths great enough to render small the perturbation effects due to migration of the bubbles under the influence of gravity. The first eight periods of oscillation were measured and the pressure-time curves analysed in order to obtain peak pressure, positive impulse, and energy flux resulting from the first two pulses. The scaling of pressure pulse parameters with charge size was examined. A.

534.222.2 2390

Secondary pressure pulses due to gas globe oscillation in underwater explosions. II. Selection of adiabatic parameters in the theory of oscillation. ARONS, A. B. *J. Acoust. Soc. Amer.*, **20**, 277–82 (*May*, 1948).—A summary is given of the theory of pulsation of a stationary gas globe in an infinite incompressible fluid. If three parameters appearing in the formulation are selected by fitting the equations to three independent experimental results, it is shown that the theory fits the remaining experimental results and can be used to predict bubble pulse properties over wide ranges of the independent variables. A.

534.222.2 : 534.24 = 4 2391

On the reflection of shock waves. HERPIN, A. *C.R. Acad. Sci., Paris*, **223**, 276–8 (*Aug.* 5, 1946) *In French.*—Formulae are given for the pressure of the gas after the passage of the wave, and for the velocity of propagation of the wave, assumed plane and moving in a cylindrical tube. Similar formulae are given for the reflected wave, and some numerical values are given of the ratios of the pressures, densities and velocities of the wave and its reflection. L. S. G.

534.23/.24 2392

Reflection and transmission of sound by a spherical shell. KELLER, J. B., AND KELLER, H. B. *J. Acoust. Soc. Amer.*, **20**, 310–13 (*May*, 1948).—A periodic point source in medium 1 is at the centre of a spherical shell of medium 2 which is surrounded by medium 3. The densities, sound speeds, and shell radii are arbitrary. An exact, explicit expression for the sound pressure is obtained. If the shell radii become infinite but the thickness remains constant, and if media 1 and 3 are the same, the solution reduces to that of Rayleigh for plane waves normally incident on a flat plate. If the shell radii become infinite and if media 2 and 3 are the same, the solution yields the acoustic Fresnel formulae for normal incidence of a plane wave on a plane interface between two half-infinite media. For finite radii, with media 1 and 3 identical and the shell thickness small compared to a wavelength, a simpler form for the solution is obtained. This solution agrees with an earlier approximate solution [Abstr. 867 (1948)] for the sound fields reflected and transmitted by a thin shell of any shape, when their result is specialized to the present case. A.

534.232 2393

The magnetostrictive radial vibrator. CAMP, L. *J. Acoust. Soc. Amer.*, **20**, 289–93 (*May*, 1948).—A description is given of a radial vibrator used in underwater sound signalling. A technique is presented for providing a plastic cast to protect the windings which serves to improve rather than decrease the potential efficiency. Data are presented to show the operating characteristics of these sound sources. A.

534.232 2394

A hydrophone suspension system. GARLAND, D. C., AND TINDAL, C. H. *J. Acoust. Soc. Amer.*, **20**, 293–6 (*May*, 1948).—A description of apparatus for suspending two transducers in a tank of water is given. The design is such that the positions and orientations of the transducers may be easily adjusted for a variety of arrangements. A.

534.232 2395

Characteristics of stepped-frequency transducer elements. BUNDY, F. P. *J. Acoust. Soc. Amer.*, **20**, 297–304 (*May*, 1948).—A common method of making transducers with broad frequency responses is to use ensembles of resonant subelements of slightly different frequencies. The theory, design, construction, and tests of a transducer of this type are presented. Six subelements of three different natural frequencies about 6% apart were used. The subelements consisted of magnetostrictive laminated nickel stacks, which were mechanically isolated from each other but linked by a common electrical winding. The relationships between the amplitude and phase responses of the unit as functions of frequency were determined experimentally and compared with the theory. The efficiency of transformation of energy was determined for the frequencies of maximum response. All the characteristics of the stepped-frequency transducer are compared to those of a less resonant, single-frequency transducer of comparable breadth of frequency response. It is found that the stepped-frequency transducer can be no more efficient than its single-frequency equivalent, and that its amplitude and phase response characteristics average about the same as the single-frequency equivalent but are more irregular. In the stepped-frequency transducer there are two frequency intervals in which the phase may remain stationary or actually decrease with an increase in frequency, but these intervals occur at the amplitude response minima. It is concluded that in practical transducer design slightly resonant single-frequency elements are superior to those made of ensembles of more resonant subelements of several different frequencies. A.

534.24 : 534.222.2 = 4 *see Abstr.* 2391

534.24 : 551.462 2396

Reflection of sound from coastal sea bottoms. LIEBERMANN, L. N. *J. Acoust. Soc. Amer.*, **20**, 305–9 (*May*, 1948).—An experimental method for measuring the reflection coefficient of the ocean bottom for supersonic sound at grazing incidence is described. In this the geometry is controlled so that the resultant of the direct and reflected rays passes through consecutive maxima and minima at the hydrophone. The amplitude reflection coefficient is given by the expression $(M - m)/(M + m)$, where M is the amplitude of a maximum and m is the amplitude of the following minimum. Using this method, with a grazing angle of nine degrees, the following values were obtained for the coefficients at 17 stations: *mud*—0 to 0·20, *mud-sand*—0·20 to 0·40, *sand-mud*—0·40 to 0·60, *sand*—0·40 to 0·85, *stony*—0·50 to 0·85. The coefficient depends not only on the median size of the particles making up the bottom, but also on the sorting of the particles and on the bottom topography. A.

534.26 2397

An experimental investigation of diffraction in the focus of a zone plate. KARPACHEVA, A. A., ROSENBERG, L. D., AND TARTAKOVSKY, B. D. *C.R. Acad. Sci. URSS*, **54** (*No.* 5) 395–7 (1946) *In English.*—Zone plates of Al, veneer and ebonite 2–3 mm thick were prepared, and the fine structure of the diffraction pattern was studied for sound waves 2·5 cm long. The focal distances (F) varied from 20 cm to 60 cm and the radii (R) of the outer rings from 15 cm to 38 cm. It was found that the shape of the curve of intensity distribution in the focal surface near the focus of the zone plate does not depend upon F/R. Also the width of the experimental curves is considerably < that given by the Fraunhofer diffraction theory. [See Abstr. 2398 (1948)]. L. S. G.

534.26 2398

Diffraction near the axis of a zone plate. MALYUZHINETZ, G. D. *C.R. Acad. Sci. URSS*, **54** (*No.* 5) 399–402 (1946) *In English.*—The plate, of focal length f_1, is composed of concentric rings, transparent and opaque alternately, the radius (r_m) of the mth ring satisfying $r_m^2 = (f + m\lambda/2)^2 - f^2$, where λ is the wavelength of sound waves falling upon the plate. The pressure at any point beyond the plate is expressed approx. as an integral

involving Bessel functions. The energy flux, Q, in the vicinity of the focus is also calculated approx. For experimental results see Abstr. 2397 (1948). L. S. G.

534.321.9 2399

The application of ultrasonics to the testing of concrete. JONES, R. *Research, Lond.*, **1**, 383–4 (*May*, 1948).—The quality and variation of quality of concrete specimens can be measured by investigating the velocity of propagation of longitudinal ultrasonic vibrations (100–250 kc/s were found to be most suitable). Cracks and internal flaws can also be detected. By conjunction with tranverse wave velocity measurements, Poisson's ratio can be evaluated.

534.321.9 : 532.12 *see Abstr.* 2362

534.321.9 : 534.845 2400

The origin of ultrasonic absorption in water. HALL, L. *Phys. Rev.*, **73**, 775–81 (*April* 1, 1948).—The origin of the excess absorption is sought in a lag in the rearrangement of the molecules during an acoustic compression. An expression is derived for such structural absorption in a liquid, and an approximate calculation is made for the case of H_2O which agrees reasonably well with the experimental excess absorption over the temperature range 0° to 80°C. A relaxation treatment is applied to the structural component of compression on the assumption of two molecular states of packing. The acoustic wave alters the equilibrium distribution of molecules between the two states by perturbing molecular transitions to and from the sites of closer packing through the work performed by or against it in the volume change accompanying the transition. The relaxation time associated with the process is found to be of the order of 10^{-12} sec for H_2O. This mechanism implies an isothermal bulk viscosity coefficient for liquids, which in the case of H_2O has a magnitude several times that of shear viscosity. A.

534.6 2401

Report on the National Electroacoustics Institute "O.M. Corbino" (I.N.E.A.C.) Rome, Italy. BOLT, R. H., AND GIACOMINI, A. *J. Acoust. Soc. Amer.*, **20**, 328–43 (*May*, 1948).—An outline of the research programme of the institute is given. This relates to ultrasonics (ultrasonic cells and light modulation, velocity and absorption measurements in liquids, crystal studies, acoustic spectrometer), vibration studies in physical acoustics, audio acoustics and instrumentation. Abstracts of 83 papers published, mostly in Italy, by members of the Institute are given.

534.647 : 53.087.6 *see Abstr.* 2317

534.75 2402

On the elasticity of the cochlear partition. V. BÉKÉSY, G. *J. Acoust. Soc. Amer.*, **20**, 227–41 (*May*, 1948).—A number of special techniques are described which are necessary in preparing the cochlea. Using these, the elasticity of the cochlear partition is determined as a function of locus along the canal. It is demonstrated that the production of undertones is very improbable because of the form of vibration in the cochlear partition and because the basilar membrane possesses no inherent stress. A.

534.756 : 530.162 2403

Brownian movement and hearing. DE VRIES, H. *Physica, 's Grav.*, **14**, 48–60 (*Jan.*, 1948).—The Brownian movement is considered at three stages of the process of hearing. (1) The Brownian movement of the air at the eardrum. This had already been done by Sivian and White [Abstr. 3722 (1933)]. The calculation is now made for an ear provided with an exponential horn. In this case the Brownian movement is very much stronger and close to the threshold of hearing. Some observations were made with a horn. (2) The Brownian movement of the vibrating system of the ear is practically the same as for an ear provided with an exponential horn. Since this Brownian movement is stronger than the Brownian movement of the air without horn, the Brownian movement of the air for a free ear is far below the threshold. (3) The thermal agitation of the sense cells leads to a serious discrepancy. On present theories it is impossible to reconcile the low audible threshold with the strong thermal agitation of the sense cells. It is emphasized that this gives an important guide in the development of theories of hearing. The damping time of the ear is calculated from other constants of the ear. A.

534.773.2 2404

The comparative performance of an experimental hearing aid and two commercial instruments. HUDGINS, C. V., MARQUIS, R. J., NICHOLS, R. H., JR., PETERSON, G. E., AND ROSS, D. A. *J. Acoust. Soc. Amer.*, **20**, 241–58 (*May*, 1948).—A series of systematic articulation tests with hard-of-hearing subjects as listeners was made. The experimental hearing aid was designed to determine to what extent certain desirable design objectives could be incorporated in a portable hearing aid. A technical description of the experimental instrument is given. The experimental methods and testing equipment employed are described and the results are summarized in the form of articulation curves obtained from six hard-of-hearing listeners. The method adequately brings out performance differences in the four instruments and shows the superiority of the experimental hearing aid over the commercial instruments for most subjects. A.

534.784 2405

Effects of high pass and low pass filtering on the intelligibility of speech in noise. POLLACK, I. *J. Acoust. Soc. Amer.*, **20**, 259–67 (*May*, 1948).—The effect of eliminating either the high frequency or the low frequency speech sounds was determined by standardized articulation testing procedures under the special circumstance of a background of white masking noise. It was found that intelligibility generally increased as the frequency range and the intensity level of the speech signal were increased. Contours are presented which describe the interrelations among (1) the frequency range of the speech signal, (2) the intensity level of the speech signal, and (3) articulation efficiency. For each of the experimental conditions, the articulation index was computed. The scatter of the computed indices, when plotted against the scores actually obtained, was of the same order of magnitude as the intrinsic variability of typical articulation scores. This result indicates that the computational procedures are an acceptable substitute for time-consuming articulation testing when an approximate assessment of the relative efficiencies of a series of communication systems is required and when a background noise is encountered like the white noise of this study. It was found that the relative contribution of the various speech frequencies was not constant, but rather was a function of the intensity of the speech signal relative to the constant white noise masking signal. As the intensity level of the speech signal was increased, the relative contribution to intelligibility of the higher speech frequencies increased. A.

534.833 2406

The absorption of sound in suspensions of irregular particles. URICK, R. J. *J. Acoust. Soc. Amer.*, **20**, 283–9 (*May*, 1948).—The greater part of the absorption in aqueous suspensions of small spherical particles is due to the viscous drag between the fluid and the particles in

the sound field. The absorption resulting from this process is found to agree with that obtained by Lamb in another manner. The applicability of the theoretical result to suspensions of irregular particles is examined by means of measurements on sand and kaolin suspensions, using a pulse-reflection method at megacycle frequencies. Approximate agreement with the idealized theory is found as the particle size, viscosity, and frequency are varied. A.

534.833.4 2407

Absorption-frequency characteristics of plywood panels. SABINE, P. E., AND RAMER, L. G. *J. Acoust. Soc. Amer.*, **20,** 267–70 (*May*, 1948).—The results of measurements of the absorption coefficients of panels made from birch plywood are given. In the range from 128 to 512 c/s measurements were made at interoctave frequencies in order to take account of the marked resonances shown. Effects of thickness of the plywood, of the air space behind the panels, and of absorbent backing were investigated, as well as that of damping material applied to the plywood. Measurements were also made on splayed assemblies of panels placed vertically against the wall of the reverberation chamber. These showed that prefabricated portable panels of the type investigated afford an easily applied means of varying the absorption-frequency characteristics of rooms of moderate size. A.

534.845 : 534.321.9 *see Abstr.* 2400

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535.14 : 530.145 *see Abstr.* 2339–40

535.2 : 537.531 *see Abstr.* 2484

535.214 + 539.155.2 + 537.3 *see Abstr.* 2467

535.231.4 2408

The spectral emissivity and total emissivity of beryllium oxide. SEIFERT, R. L. *Phys. Rev.*, **73,** 1181–7 (*May* 15, 1948).—A method was devised for the measurement of the emissivities of non-metallic surfaces at high temperatures. The maximum temperature for spectral emissivity measurements is about 1 700°c. With an extrapolation of spectral emissivity values it is possible to obtain experimental values for total emissivities at even higher temperatures. This method has been applied in the measurement of the emissivities of polished surfaces of three types of commercially prepared beryllia. Ceramic firing of hot-pressed beryllia was found to have very little, if any, effect on the spectral or total emissivity of a surface formed by polishing the final material. The impurity present in dark samples and/or the larger crystal size increases both the spectral and total emissivity by a factor of about 2. A.

535.231.4 : 535.343–15 2409

Erratum: Comparison of glower and globar sources for infra-red spectrometry. FRIEDEL, R. A., AND SHARKEY, A. G., JR. *Rev. Sci. Instrum.*, **19,** 180 (*March*, 1948).—[Abstr. 904 (1948)].

535.231.4 : 536.24.083 *see Abstr.* 2441

535.317 : 526.918.5 : 535.8 *see Abstr.* 2427

535.317.25 : 771.351 2410

The photographic and visual resolving power of lenses. I. Visual resolving power. SELWYN, E. W. H. *Photogr. J.*, **88 B,** 6–12 (*Jan.–Feb.*, 1948).—If the object under examination consists of long parallel strips across which the variation of brightness follows a sine-curve, the brightness variation across the image produced by the lens also follows a sine-curve. The amplitude of the intensity variation in the image may be calculated from the intensity distribution in the image of a line source; it varies with the separation between lines in the image, and, apart from possible minor oscillations, decreases as the separation decreases. The adoption of such sine-curve test objects results in considerable simplification of theoretical arguments. By means of observations of sine-curve test objects of different contrasts the minimum variation of brightness in the image, relative to the mean brightness, which is sufficient to enable the eye to resolve the image, was found to be $\pm 0{\cdot}02$, and about twice that amount for easy resolution. This holds for apparent separations between lines in the magnified image of 6–12 minutes of arc. As the apparent separation is diminished below 6 minutes the threshold contrast for resolution increases rapidly. This is attributed to coarseness of structure of the retina. The observations and interpretation adopted are shown to be consistent with Cobb's observations on the acuity of the eye at different pupil apertures. To find the visual resolving power of a lens, therefore, the curve relating contrast in the image to the separation between lines is calculated from the energy distribution in the image of a line source, and the separation determined at which the contrast has the value $0{\cdot}02$. A.

535.317.4–1 : 535.338.35 : 535.42 : 536.521 = 4 *see Abstr.* 2453

535.317.9 : 535.81 2411

Preparation of aspherical refracting optical surfaces by an evaporation technique. SCHULZ, L. G. *J. Opt. Soc. Amer.*, **38,** 432–41 (*May*, 1948).—By selective deposition of evaporated dielectrics it was found possible to form aspherical surfaces on plane glass plates which, when used with a lens, made the combination free from spherical aberration. A theory is given for the calculation of the correcting surfaces, and the experimental procedure for their preparation is described. The results are shown by means of ronchigrams. A.

535.33 : 523.77 *see Abstr.* 2312

535.33 : 536.46 *see Abstr.* 2445

535.33.072 : 621.383.2 2412

An electronic eyepiece for spectroscopy of near infra-red. HARVALIK, Z. V. *Rev. Sci. Instrum.*, **19,** 254–7 (*April*, 1948).—The eyepiece may be used for the observation of the near infra-red. It can be attached to any spectroscope and consists of an image tube of the type 1-P-25 which converts an infra-red image into a visible one. The spectrum is projected by the telescope system of the spectroscope upon the photo-cathode of the image tube. The infra-red radiation releases photoelectrons which are focused electron-optically upon a fluorescent screen. The image appearing on the fluorescent screen can be observed directly or magnified optically. The visible range of a spectroscope equipped with an electronic eyepiece is extended to approximately 1 150 mμ in the infra-red and to 300 mμ in the ultraviolet. A.

535.331 2413

Relative transition probabilities in the spectra of Ti I and Ti II. VAN STEKELENBURG, L. H. M., and SMIT, J. A. *Physica, 's Grav.*, **14,** 189–96 (*May*, 1948) *In English.*—The probabilities of several lines were measured in emission and compared with the results obtained by King and King who measured the oscillator strength by an absorption method. [Abstr. 537 (1938)]. A.

535.337 : 538.615 2414

The Zeeman effect in the first selenium spark spectrum. VAN DEN BOSCH, J. C. *Physica, 's Grav.*, **14,** 249–59 (*May*, 1948).—Zeeman effect data for several lines of the Se II spectrum are obtained by photographing the spectrum with a big Rowland grating in stigmatic mounting. The light source was placed in a magnetic

field of about 38 000 oersted. From the data the g-values of 47 levels given by Martin [Abstr. 682 (1936)] are calculated. The g-sum rule is considered for the configurations $4s^24p^25s$ and $4s^24p^25p$. There is a strong deviation from LS-coupling. A.

535.338.332 : 539.152.2 *see Abstr.* 2531

535.338.35 : 535.42 : 535.317.4–1 : 536.521 = 4 *see Abstr.* 2453

535.338.4 : 539.133 2415

Dissociation energy of the NO molecule. Gerö, L., and Schmid, R. *Proc. Phys. Soc., Lond.*, **60**, 533–40 (*June*, 1948).—During a new investigation of the NO band spectrum many bands of the β and γ system were photographed and analysed, and the rotational constants evaluated. Intensity drops and perturbations were found and two predissociation limits at 53 800 and 50 500 cm^{-1} were established. In this way the dissociation energy of NO is fixed at 4·29 eV. The $x^2\Pi$ ground state of NO dissociates in the $N(^2D) + O(^3P)$ atomic term combination. The new dissociation scheme is strongly supported by the results of photochemical experiments. A.

535.338.42 : 539.152.1 *see Abstr.* 2522

535.339 : 548.73 *see Abstr.* 2629

535.34 : 537.531 *see Abstr.* 2485

535.343–15 : 535.231.4 *see Abstr.* 2409

535.343.2 : 548.7 2416

Temperature dependence of electron energy levels in solids. Radkowsky, A. *Phys. Rev.*, **73**, 749–61 (*April* 1, 1948).—In many crystalline insulators there is a displacement, proportional to the temperature, of the long wavelength absorption limit towards longer wavelengths. These are crystals which have a broad, nearly structureless absorption which is caused by the transition of an electron from a full to an empty electron band. It is shown that there is a broadening of electron energy levels due to collisions with the thermally vibrating lattice which results in reducing the effective width of the "forbidden" energy region between occupied and conducting bands. Calculations indicate that, in polar crystals for which the observations have been made, this effect is of the proper magnitude to explain the experimental data. In non-polar crystals the effect would be very small. No absorption shift in non-polar crystals has been observed. A.

535.343.31–15 2417

The infra-red spectrum of heavy water vapor. Dickey, F. P., and Nielsen, H. H. *Phys. Rev.*, **73**, 1164–73 (*May* 15, 1948).—The vibration-rotation bands ν_2 and ν_3 in the D_2O vapour spectrum were remeasured. An analysis of the rotational structure was carried out. From the interpretation of the data the values of the normal frequencies were determined as well as the values of the reciprocals of inertia effective in these two vibration states. The frequency ν_2 is found to be 1 178·30 cm^{-1}, and the frequency ν_3, 2 787·23 cm^{-1}. For the state ν_2 the effective reciprocals of inertia are $A(V) = 16·60$ cm^{-1}, $B(V) = 7·35$ cm^{-1}, $C(V) = 4·84$ cm^{-1}. For the state ν_3, $A(V) = 14·88$ cm^{-1}, $B(V) = 7·24$ cm^{-1}, $C(V) = 8·84$ cm^{-1}. A.

535.343.32 2418

The absorption of light in solutions of the rare earth salts. Hoogschagen, J., and Gorter, C. J. *Physica, 's Grav.*, **14**, 197–206 (*May*, 1948).—Continuation of earlier work [Abstr. 3130 (1947)]. The absorption spectra of aqueous solutions of europium, terbium and erbium salts are reported. A list of the oscillator strengths of all rare earths is given and the results are shown in a diagram. A.

535.343.4 241

Blue and ultra-violet bands of K_2. Sinha, S. P. *Proc. Phys. Soc., Lond.*, **60**, 436–43 (*May*, 1948).—Bands of K_2 were photographed in absorption in the region λ4510–λ3940 Å in the first order of a 21-ft concave grating with a dispersion of about 1·28 Å per mm. The bands measured fall into two systems, one lying between λ4510 and λ4220 Å and the other between λ4160 and λ3940 Å. Equations representing the systems are given. The upper states of the two systems are considered to dissociate into $4^2S + 5^2P$ and $4^2S + 3^2D$ atoms respectively. A.

535.343.4–14 242

Structure of the inversion spectrum of ammonia. Simmons, J. W., and Gordy, W. *Phys. Rev.*, **73**, 713–18 (*April* 1, 1948).—Measurements of the fine structure have been extended to the 16,16 line at 39 941 Mc/s. The relative intensities and positions of the lines are compared with calculated values. The hyperfine structures of 15 lines have been measured. A systematic disagreement is shown to exist between the theoretical and observed separations of the hyperfine components. There is good agreement between the observed and calculated intensities of the hyperfine structure. A.

535.343.4–14 2421

Saturation effect in microwave absorption of ammonia. Carter, R. L., and Smith, W. V. *Phys. Rev.*, **73**, 1053–8 (*May* 1, 1948).—Attenuation and line width for the NH_3 3,3 line were measured as a function of the intensity of radiation incident on the gas for several different pressures. The saturation effects were found to be proportional to the power and inversely proportional to the square of the line width, in agreement with theory. An estimate of the collision cross-section given by saturation data is in agreement with that deduced from collision broadening data. A.

535.343.4–14 2422

Collision and saturation broadening in microwave spectra. Snyder, H. S., and Richards, P. I. *Phys. Rev.*, **73**, 1178–80 (*May* 15, 1948).—A theory of spectral line shape is presented for the case of a low pressure gas where only two energy levels are active in producing absorption. An approximate set of differential equations is derived and solved. A definite broadening of the lines in addition to that due to molecular collision is predicted as saturation is approached. The incident power needed for a given effect is proportional to the square of the pressure, and the maximum attenuation factor multiplied by the square of the half-width should be independent of incident power. A.

535.343.4–14 : 539.13 2423

Collision broadening of the inversion spectrum of ammonia: III. The collision cross-sections for self-broadening and for mixtures with non-polar gases. Bleaney, B., and Penrose, R. P. *Proc. Phys. Soc., Lond.*, **60**, 540–9 (*June*, 1948).—The widths of the lines of the inversion spectrum near 1 cm^{-1} [Abstr. 1180 (1947), 723 (1948)] are shown to vary from line to line in a manner consistent with the assumption of a simple dipole–dipole interaction for the collision mechanism. Measurements of the line breadth constant for the line $(J,K) = (3,3)$ in mixtures of ammonia with six different non-polar gases are described, and from them the collision diameters are calculated. They are found to be approximately the same as the diameters obtained from the kinetic theory, whereas in pure ammonia the diameters are two to four times greater. A survey of microwave spectra indicates that the collision diameter is only significantly greater than

the kinetic theory diameter for encounters between permanent electric dipoles. A.

535.343.4–14 : 539.132 2424

A note on saturation in microwave spectroscopy. KARPLUS, R., AND SCHWINGER, J. *Phys. Rev.*, **73**, 1020–6 (*May* 1, 1948).—The investigation of Van Vleck and Weisskopf [Abstr. 748 (1946)] on the shape of collision-broadened absorption lines, is extended to high power levels of the exciting radiation. Transitions among the molecular states are induced at a rate that is not negligible compared with the collision rate, thus invalidating the assumption of thermal equilibrium. The theory is based on a quantum transcription of the previous semi-classical treatment, the essential tool being the density matrix. When the resonant frequencies of the molecule are widely spaced, an absorption line is ultimately broadened as the power level increases. Correspondingly, the peak absorption coefficient decreases, the power absorbed per unit volume approaching saturation with increasing incident power. It is shown that the broadening of an absorption line is not to be attributed to any intrinsic modification of the line shape, but rather to a frequency-dependent alteration of the energy level populations. A molecule for which all resonant frequencies coincide, a one-dimensional harmonic oscillator, is also treated. No saturation effect occurs here, since the absorption is independent of the molecular distribution among the oscillator energy levels. A.

535.343.4–14 : 539.132 2425

Frequency modulation in microwave spectroscopy. KARPLUS, R. *Phys. Rev.*, **73**, 1027–34 (*May* 1, 1948).—The absorption coefficient of a gas is related to the density matrix, which is obtained formally from the equation of motion. This takes into account a possible time-dependence of the resonant frequency of the molecule and of the frequency of the exciting radiation. The shape of the absorption line is calculated explicitly in a variety of cases. For low-frequency modulation, it reduces to Lorentz's expression with a time-dependent frequency difference. For high-frequency sinusoidal modulation, resolved sidebands to the resonant frequency are obtained. For square wave modulation, the line shape is again given by Lorentz's expression with a varying frequency difference, except that damped oscillations are superimposed on the expected square wave time-dependence. In this case, the deviations from the Lorentz expression are no greater than about 10% for the zero frequency and fundamental frequency components, if the modulation frequency is less than one-half of the half-width of the absorption line. A.

535.343.4–31 2426

Ultra-violet bands of Li_2. SINHA, S. P. *Proc. Phys. Soc., Lond.*, **60**, 443–7 (*May*, 1948).—The bands of Li_2 were photographed in absorption on a quartz spectrograph, using Li_2 vapour in argon at a pressure of half an atmosphere, at temperatures between 900 and 1 100°C. Bands appear between λ3500 and λ3100 Å. The equation representing the band heads is given. The upper state of this system of bands is considered to dissociate into $2\ ^2S + 3\ ^2P$ atoms of lithium. A.

535.343.4–31 2427

Ultra-violet bands of NaK. SINHA, S. P. *Proc. Phys. Soc., Lond.*, **60**, 447–53 (*May*, 1948).—Bands due to NaK, in the region λ3820 to λ4080 Å, were photographed in absorption in the first order of a 21-ft concave grating and their vibrational analysis carried out. The constants for this system were evaluated. The system is regarded as arising from transitions from the ground $^1\Sigma^+$ state to an excited state dissociating into Na $3\ ^2S + $ K $3\ ^2D$ atoms. A.

535.343.9 : 535.372 2428

The absorption and fluorescence spectra of bivalent europium ion in crystals. FREED, S., AND KATCOFF, S. *Physica, 's Grav.*, **14**, 17–28 (*Jan.*, 1948) *In English.*—The spectrum of Eu^{++} consists, both in absorption and in fluorescence, of broad bands which show signs of an underlying discreteness at liquid air temperatures and at the temperature of liquid hydrogen become resolved into lines in some regions. The spectrum of Eu^{++} in crystals is one hundred to one thousand times as intense as the spectrum of Gd^{+++}. To obtain transmission, the bivalent salts were greatly diluted to form mixed crystals with the corresponding colourless strontium salt. In contrast with the spectra of Gd^{+++}, the spectra of Eu^{++} are rich in vibrational structure, with an interval 215 cm^{-1} as especially prominent in the anhydrous chloride. The spectra of Eu^{++} are also exceptional in their strong dependence on the crystalline environment about the europium ions. The character of the spectrum is ascribed principally to transitions between a sharp basic level $^8S_{7/2}$, with the seven "optical" electrons in the $4f$ shell and activated states having one of these electrons in a $5d$, $6s$, $6p$, etc., or the lattice. It is possible that some of the sharp activated states which correspond to those in Gd^{+++} have nearly the same energy as those which have one electron in the outer shells of the ion or in the lattice and thus resonance arises between the "inner" and "outer" states. Some evidence is offered for such radiationless transitions and for transitions to the lattice. A.

535.361.2 2429

Coefficients of reflection of magnesium oxide and magnesium carbonate. BENFORD, F., LLOYD, G. P., AND SCHWARZ, S. *J. Opt. Soc. Amer.*, **38**, 145–7 (*May*, 1948).—Both $MgCO_3$ and MgO are used as reflectors of visible radiation and a knowledge of their spectral characteristics is desirable. The method used to measure coefficients of reflection depends on the variation of brightness within a spherical integrator when a section of the surface is removed or added. The photometry was done with a Macbeth instrument and interference filters were used to get six zones in the spectrum. The centroids were computed for low levels of luminosity. By taking photometric readings with three part-spheres of different degrees of completeness, the coefficients were computed for three different combinations, and comparison of results indicates the consistency of results. The average coefficient of $MgCO_3$ was found to be about 0·983, while that of the oxide was about 0·991, and both have a slight selectivity in favour of the red end of the spectrum. A.

535.37 2430

A method for automatically plotting spectral energy distribution of luminescent materials. STUDER, F. J. *J. Opt. Soc. Amer.*, **38**, 467–70 (*May*, 1948).—In the method described, a photo-multiplier operated on d.c. is used with a standard constant-deviation spectrometer for measuring the energy in the spectrum. A compensator was built in the spectrometer so that the output of the photo-cell is proportional to incident energy of any wavelength. A drive mechanism sweeps the spectrum across the exit slit at constant wavelength rate, and the photo-cell output appears on the chart of a standard photoelectric recorder. Errors, due chiefly to inaccuracies in milling the compensator, are less than 5% except in the extreme violet. Curves repeat within 1 or 2%. Spectral curves can be taken of surfaces whose brightness is as low as 1 foot lambert. The time to obtain a distribution

curve may be varied from one-half to two minutes by a change of gears. A.

535.37 2431

The $CaSiO_3$: (Pb + Mn) phosphor. MERRILL, J. B., AND SCHULMAN, J. H. *J. Opt. Soc. Amer.*, **38**, 471–9 (*May*, 1948).—A $CaSiO_3$ phosphor, activated by Pb and Mn, is described, and the conditions for its preparation are presented. Under excitation by a low pressure Hg discharge this phosphor luminesces with an emission lying principally in the red end of the spectrum and with a high efficiency comparable to that of zinc beryllium silicate of the same luminescence colour. Data are presented on the spectral emission of $CaSiO_3$: Pb, $CaSiO_3$: Mn, and $CaSiO_3$: (Pb + Mn), both under cathode-ray and under 2 537 Å excitation. It is shown that $CaSiO_3$: Mn is excited to luminescence in the red end of the spectrum by cathode rays but not by ultra-violet light. The introduction of Pb as an auxiliary impurity makes possible the excitation of this material by radiation in the neighbourhood of the Hg resonance line. Qualitative absorption experiments indicate that the lack of response of $CaSiO_3$: Mn to 2 537 Å excitation is due to the absence of an absorption for this radiation; and that Pb acts as a sensitizer for the manganese by introducing an absorption band in the vicinity of 2 537 Å. The presence of a sensitizer is unnecessary under cathode-ray excitation, since in this case the energy is absorbed by the host crystal itself. A.

535.371 2432

The influence of temperature quenching on the decay of fluorescence. KRÖGER, F. A., HOOGENSTRAATEN, W., BOTTEMA, M., AND BOTDEN, T. P. J. *Physica, 's Grav.*, **14**, 81–96 (*April*, 1948).—Temperature quenching causes a marked increase of the rate of decay. Both the efficiency of fluorescence and the decay are determined by the probabilities of the fluorescence transition and of a radiationless transition. By combining data from measurements of the efficiency and the decay, it is possible to obtain the two transition probabilities separately, and both as a function of the temperature. The results with $(NH_4)_3UO_2F_5$ and $Mg_2TiO_4 . Mn^{4+}$ were used to verify that the radiationless process follows the theory of Mott and Seitz [Abstr. 679 (1939), 4069 (1938)]. A.

535.371 2433

The electron trap mechanism of luminescence in sulphide and silicate phosphors. GARLICK, G. F. J., AND GIBSON, A. F. *Proc. Phys. Soc., Lond.*, **60**, 574–90 (*June*, 1948).—Electrons escaping from the traps give rise to emission when they recombine with luminescence centres, but there is a probability that they may be retrapped in empty electron traps before their final recombination with centres. Theoretical and experimental studies are made of the extent to which retrapping occurs and what effects it will have in modifying the phosphorescence and thermo-luminescence characteristics. Theory shows that there are marked differences in these characteristics for conditions when the retrapping process is present and for those when it is negligible. Experimental investigations of the characteristics of specimens of Zn sulphide, Zn silicate and Sr silicate phosphors indicate that, except under special conditions, retrapping of electrons is negligible. These results together with other work can be explained theoretically if it is assumed that electron traps operative in the luminescence process are spatially associated with the immediate neighbourhood of the luminescence centres formed by activating impurities. This new concept is also supported by the relations found between the luminescence characteristics and the dielectric changes in phosphors of the Zn sulphide type. A.

535.372 : 535.343.9 *see Abstr.* 2428

535.39 = 4 2434

On the intensity transmitted by a transparent plate in conditions of pseudo-total reflection. ARZELIES, H. *C.R. Acad. Sci., Paris*, **226**, 478–80 (*Feb.* 9, 1948) *In French.*

535.42 : 535.317.4–1 : 535.338.35 : 536.521 = 4 *see Abstr.* 2453

535.43 2435

New contributions to the optics of intensely light-scattering materials. I. KUBELKA, P. *J. Opt. Soc. Amer.*, **38**, 448–57 (*May*, 1948).—The differential equations for the scattering were derived from a simplified model of travel of light in the material. These were converted into exact equations and integrated. Formulae for the reflectance and transmittance were derived. In many practical cases the exact formulae may be replaced by appropriate approximations. A.

535.43 : 537.531 *see Abstr.* 2486

535.653 2436

Non-adaptability of the ICI system to some near-whites which show absorption in the far blue region of the spectrum. JACOBSEN, A. E. *J. Opt. Soc. Amer.*, **38**, 442–4 (*May*, 1948).—Attempts to correlate readily recognizable chromatic differences between two near-white paints, which contain the widely used rutile and anatase titanium dioxide pigments, with colorimetric data calculated from spectrophotometric curves, by the accepted procedure, have been unsuccessful. The curves for these materials are essentially identical from 430 to 700 mμ but differ in selective absorption from 430 mμ and below. Readings with the Hunter multi-purpose reflectometer for these two paints are identical. The evidence shows that the GE recording spectrophotometer is capable of measurement of the spectral differences, but the ICI system does not correctly weight the blue region of the spectrum in accord with visual perception. A.

535.8 : 535.317 : 526.918.5 2437

Lenses of extremely wide angle for airplane mapping. GARDNER, I. C., AND WASHER, F. E. *J. Opt. Soc. Amer.*, **38**, 421–31 (*May*, 1948).—See Abstr. 1832 (1948).

535.8 + 536.5/.6 + 531.7 *see Abstr.* 2359

535.81 2438

An adjustable lamp-holder of kinematic design. ROSS, H. MCG. *J. Sci. Instrum. Phys. Ind.*, **25**, 244 (*July*, 1948).—The lamp-holder was constructed from a tube into which a projector lamp is rigidly mounted. A spring-loaded stud holds the tube against two pivots at the bottom, mounted with their axes mutually perpendicular, and against two adjusting screws at the top. One of the screws is parallel to the optic axis, while the other is perpendicular to it, thus allowing adjustment of the filament along and across the axis. A.

535.81 : 535.317.9 *see Abstr.* 2411

535.822 2439

Phase-contrast in polarized light. KASTLER, A., AND MONTARNAL, R. *Nature, Lond.*, **161**, 357 (*March* 6, 1948).—A development of Hartley's system [Abstr. 2537 (1947)] is described, in which continuous control of the amplitude of the dioptric rays is obtained without alteration of the phase relationship with the diffracted rays. Positive or negative phase-contrast can thus be obtained as desired. Some photographs are shown.

535.89 : 539.16.08 2440

A powerful light source for the illumination of Wilson cloud chambers. WARMOLTZ, N. *Appl. Sci. Res.*, **B 1**

(*No.* 2) 139–42 (1948).—A capillary flash-tube is described for photographing the tracks in the chamber. At an energy input of 500 W sec per flash and with a choke in series with the flash-tube the light output amounts to 15 000 lumen.sec per flash. At that energy and at a rate of 8 flashes per min, the lifetime of the tube exceeds 100 000 flashes. At about 320 W sec the light output is amply sufficient for photographing cloud chamber tracks. A.

HEAT 536

536.24.083 : 535.231.4 2441

Heat transfer by radiation to surfaces at low temperatures. BLACKMAN, M., EGERTON, A., AND TRUTER, E. V. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 147–69 (1948).—A study of the transfer of heat between the walls of vacuum vessels was made. The heat transferred from the outer wall at ordinary temperature to the inner vessel at 90°K is greater than would be expected from the reflectivity of the inner wall, as estimated from its electrical conductivity. The apparent emissivities at 90°K of Cu, Ag, Au, Sn, brass, Al, steel and graphite were determined. It was found that a freshly reduced smooth surface of copper was more efficient in diminishing the heat transfer than a highly polished surface. A.

536.244 2442

Thermal conductivity of gaseous hydrogen and of gaseous deuterium. UBBINK, J. B. *Commun. K. Onnes Lab., Leiden* (*No.* 273*b*). *Physica, 's Grav.*, **14**, 165–74 (*April*, 1948) *In English.*—For experimental measurements see Abstr. 1468 (1945). The measurements are given between 273°K and 14°K. Comparison between the theoretical and experimental values is carried out. A.

536.42/.44 = 3 2443

Evaporation, condensation, saturation pressure and critical point demonstrated and filmed in an instructional model. STUART, H. A. *Z. Phys.*, **124** (*Nos* 3–6) 348–50 (1948) *In German.*—Small magnets are used as "molecules," agitated in a box with one moveable side.

536.423 : 536.48 *see Abstr.* 2450

536.423.15 2444

Vapour pressure of methylfluoride. MICHELS, A., AND WASSENAAR, T. *Physica, 's Grav.*, **14**, 104–10 (*April*, 1948) *In English.*—The pressure was measured between −110°C and +15°C. The temperature was measured with a Pt-resistance thermometer, the pressure up to 4 atm. against a mercury column and for higher pressures with a pressure balance. A sketch of the apparatus used is given. A.

536.46 : 535.33 2445

Spectroscopic studies of low-pressure flames; temperature measurements in acetylene flames. GAYDON, A. G., AND WOLFHARD, H. G. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 169–84 (1948).—Flames at very low pressure have a relatively thick reaction zone and are especially suitable for detailed study of the combustion processes and of the distribution of energy during the reaction. Temperature measurements were made, by various spectroscopic methods, on flames of acetylene with air, O_2 and N_2O, in some cases down to a pressure of 1·5 mm Hg. The excitation temperature was measured through the reaction zone by the spectrum-line reversal method using Fe, introduced as the carbonyl; the characteristics of the flame containing $Fe(CO)_5$ are described. The rotational temperature of the excited OH radicals was determined from the emission spectrum; at pressures above 10 mm it is fairly constant at around 5 700°K, but at lower pressure rises to a higher value of nearly 9 000°K. The results are explained in terms of the collision and radiative de-activation of the electronically excited OH radicals. These radicals are believed to be formed, as the result of chemical reaction, in the excited $^2\Sigma$ state and with a rotational energy equivalent to above 9 000°K. De-activation by collision appears to occur on the average after about forty collisions, if a normal collision diameter is assumed. Removal of electronic excitation occurs mainly by collisions with O_2 molecules, but CO_2 or CO molecules are most effective in removing rotational energy. The variation of concentration of OH through the reaction zone has been determined by its absorption spectrum; it is abnormally high just below the visible reaction zone. Calculations of flame temperature and composition are given. The lack of equipartition of energy is discussed. A.

536.461 2446

The influence of incombustible vapours on the limits of inflammability of gases and vapours in air. BURGOYNE, J. H., AND WILLIAMS-LEIR, G. *Proc. Roy. Soc. A*, **193**, 525–39 (*July* 21, 1948).—The influence upon the upward propagation of flame through mixtures of combustible gases and vapours with air contained in a 1¾-in glass tube was examined and some comparisons made with results in a 4-in tube. From the data obtained with the smaller tube, diagrams were plotted for each of the combustibles with inert vapour and air showing completely the compositions of inflammable and non-inflammable mixtures. From these, the limiting "safe" composition of mixtures of inert vapour with air and with the combustible respectively were derived. The combinations studied were H_2, CH_4, C_2H_4, CO, *n*-hexane, cyclohexane and benzene with MeBr; H_2 and *n*-hexane with difluorodichloromethane, and methane with CCl_4. A sample of coal gas, the composition of which was determined, was also examined with MeBr as the inert vapour, and it is shown that the limit curve agrees fairly well with that calculated by Le Chatelier's rule from the curves for its constituents. A.

536.462 : 536.5 2447

Measurements in the reaction zone of a Bunsen flame. KLAUKENS, H., AND WOLFHARD, H. G. *Proc. Roy. Soc. A*, **193**, 512–24 (*July* 21, 1948).—Direct measurements in the reaction zone of a Bunsen flame were made by using a "low-pressure flame," the flame being then drawn out and enlarged. The temperature-course through the flame front was measured. The position of the Schlieren picture was deduced and compared with the actual photographed Schlieren picture. The heat flow in the reaction zone was calculated; it is responsible for the formation of a considerable preheating zone. A.

536.48 2448

Low temperature and some of its effects upon the behavior of matter. COLLINS, S. C. *Science*, **107**, 327–33 (*April* 2, 1948).—A short non-mathematical review, covering production of low temperatures, superconductivity, superfluidity (35 references).

536.48 2449

On solutions of He^3 in He^4. LONDON, F., AND RICE, O. K. *Phys. Rev.*, **73**, 1188–93 (*May* 15, 1948).—Elementary thermodynamics was applied to recent data on the equilibrium concentrations of He^3 in the liquid and vapour phases of He^4. The differences between He^3 and He^4 as regards partial molar heat and entropy were calculated. Above the λ-point the energy of He^3 in the liquid is greater than that of He^4 by about 13 cal/mole, an amount which can be accounted for theoretically by the difference in zero-point energy. But below the λ-point the energy and entropy of He^3 are considerably

lower than those of He^4 in the same solution. The entropy decrease per He^3 atom dissolved is equivalent to the entropy contents of about 50 He^4 atoms in pure liquid helium II. An explanation of this strange result is suggested by Tisza's hypothesis that below the λ-point He may be considered to be a mixture of a "normal" and a "superfluid" phase. The thermal data obtained lead to the conclusion that the λ-transition of pure He^4 might become a transition of first order in dilute solutions of He^3 in He^4. On this basis, the effect of concentration of He^3 on the λ-point is considered. A.

536.48 : 532.7 *see Abstr.* 2275

536.48 : 536.423 2450

The rate of evaporation of liquid hydrogen due to the ortho-para hydrogen conversion. LARSEN, A. H., SIMON, F. E., AND SWENSON, C. A. *Rev. Sci. Instrum.*, **19,** 266–9 (*April*, 1948).—The evaporation, caused by the heat of reaction of the ortho-para conversion, was measured as a function of the *o*-hydrogen concentration. The results are discussed, and a set of curves is given which describes all cases of practical interest. Methods of minimizing the rather serious evaporation of liquid hydrogen as the result of this effect are suggested. A.

536.48 : 536.5.081 : 538.222 2451

Magnetic observations and thermometry in the region of millidegrees absolute. DE KLERK, D., STEENLAND, M. J., AND GORTER, C. J. *Nature, Lond.*, **161,** 678 (*May* 1, 1948).—The temperature T^* derived from adiabatic demagnetization measurements departs considerably from the true temp. at the lowest limits of temp. where deviations from the Curie law exist. By experiments on a spherical single crystal of CrK alum, T^* was calibrated against the thermodynamic scale, and also the width of the hysteresis loop which occurs below $T = 0{\cdot}005°$ A; the latter proved to be a useful thermometer. In the intermediate region ($T^* < 0{\cdot}06°$ A) paramagnetic losses may also prove a useful thermometer. Methods of supplying heat to the salt are briefly discussed.

536.48 : 537.311.31 *see Abstr.* 2469

536.48 : 539.155.2 2452

A new isotopic effect in liquid helium. DAUNT, J. G., PROBST, R. E., AND JOHNSTON, H. L. *Phys. Rev.*, **73,** 638 (*March* 15, 1948).—Helium of an initial concentration $He^3/He^4 = 2{\cdot}4 \times 10^{-5}$ is condensed into a container A and then allowed to flow isothermally by superfluid flow at 1·57°K into a previously empty container B. A loose fitting plug prevents gas exchange between the containers. The flow stops when the level in B is still 2·1 mm below the level in A. Gas well He of a He^3 concentration of $1{\cdot}6 \times 10^{-7}$ does not show this effect. The phenomenon is tentatively ascribed to the osmotic pressure of the He^3 in A, the film being permeable only for He^4. H. L.

536.48 : 539.155.2 *see Abstr.* 2535

536.48 : 548.7 : 538.214 *see Abstr.* 2504

536.483 : 533.24 *see Abstr.* 2377–8

536.5 : 536.462 *see Abstr.* 2447

536.5.081 : 538.222 : 536.48 *see Abstr.* 2451

536.521 : 535.338.35 : 535.42 : 535.317.4-1 = 4 2453

The influence of spherical aberration and diffraction on the measurement of temperature by the method of line reversal. BARRET, P. *C.R. Acad. Sci., Paris*, **226,** 396–7 (*Feb.* 2, 1948) *In French.*—Spherical aberration of the lenses and diffraction at the spectroscope slit introduce errors of ~50–100°C in the measurement of temp. of a Bunsen flame by the line reversal method using Li, Na and Cs lines. The precautions and arrangement necessary to avoid these errors are stated, and an example given of a suitable optical arrangement which, in practice, gave temps. within 5°C for the different lines. S. W.

536.522.3 2454

Approximate measurement of color temperature with a barrier-layer photocell. MIDDLETON, W. E., AND RAMSEY, A. R. *Canad. J. Res., A*, **26,** 23–8 (*March*, 1948).—Equipment for measuring the temperature is described, and the limitations of the method are pointed out. A.

536.522.3 = 3 2455

Temperature measuring colours and pencils. Applications. GUTHMANN, K. *Arch. tech. Messen, Issue* 152 (*Ref. V*215–4) *T*4–5 (*July*, 1947) *In German.*—Thermocolours change their colour at various definite temperatures. They are applied by painting, spraying or colour pencils. Comparison with Hg thermometers show that the colour change is not instantaneous, though rapid, and is affected by time of heat exposure. The paper describes an application of thermocolours to cooling fins of aircraft engines. Thermocolours have been applied to determine the temperatures of moving parts like pistons, etc. This is possible since any colour change remains until the component has cooled down. Applications to blast furnaces, rolling mills and various heat processes are discussed. V. W. R.

536.58 2456

The control of the temperature of endothermic reactions in flow systems. GADSBY, J., AND SYKES, K. W. *Proc. Roy. Soc. A*, **193,** 400–6 (*July* 2, 1948).—An apparatus is described, utilizing two relay circuits operated by suitably spaced thermocouples, by which the desired automatic regulation of temperature can be achieved. A.

536.633.1 : 536.782=3 2457

The Joule–Thomson effect and the specific heat at constant pressure of carbon dioxide. DE GROOT, S. R., AND MICHELS, A. *Physica, 's Grav.*, **14,** 218–22 (*May*, 1948) *In German.*—These were calculated for the temperature range 25°–150°C and for pressures between 1 and 2 000 atmos.

THERMODYNAMICS 536.7

536.7 2458

Thermodynamical properties of carbon dioxide as function of density and temperature. MICHELS, A., AND DE GROOT, S. R. *Appl. Sci. Res.*, **A 1** (*No.* 2) 94–102 (1948).—The specific heats, energy, enthalpy, entropy, free energy, thermodynamic potential and kinetic energy of CO_2 were recalculated [Abstr. 3184 (1937)] for densities up to 600 Amagat units (pressures to 3 000 atmospheres) between 25° and 150°C. A.

536.7 2459

Thermodynamical properties of carbon dioxide as function of pressure and temperature. MICHELS, A., AND DE GROOT, S. R. *Appl. Sci. Res.*, **A 1** (*No.* 2) 103–6 (1948).—Tables are given for pressure × volume, enthalpy, energy, entropy, free energy, thermodynamic potential and internal kinetic energy of CO_2 for round values of pressure up to 2 000 atmospheres between 25° and 150°C. A.

536.71 2460

Quantum theory of condensed permanent gases. I. The law of corresponding states. DE BOER, J. *Physica, 's Grav.*, **14,** 139–48 (*April*, 1948) *In English.*—It is shown that the equation of states of the gases, H_2, D_2 and N_2 can be written in a reduced form, in which thermodynamic quantities are expressed in "molecular units," i.e. units obtained from the characteristic parameters of the inter-

molecular field. In general the reduced equation of states contains a parameter Λ^*, containing also h and the mass of the molecules, which measures essentially the influence of quantum mechanics on the phenomenon considered. When classical statistics can be applied and $\Lambda^* = 0$, the reduced equation of states implies the law of corresponding states in its classical form. The reduction with molecular units is applied to the condensed phase of the substances mentioned above to study experimentally the thermodynamical properties as a function of Λ^* and to obtain in this way information on the influence of quantum theory on these phenomena. A.

536.782 : 536.633.1 *see Abstr.* 2457

ELECTRICITY 537

537.1 : 621.317 2461

Electrical indicating and measuring instruments shown at the Physical Society's Exhibition. SHOTTER, G. F. *J. Sci. Instrum. Phys. Ind.*, **25**, 181–2 (*June*, 1948).

537.122 : 530.145 *see Abstr.* 2341

537.122 : 530.145 = 4 *see Abstr.* 2342–3

537.122 : 537.311.31 *see Abstr.* 2470

537.122 : 539.11 : 537.531 2462

The energies of electrons in aluminium. MATYÁŠ, Z. *Phil. Mag.*, **39**, 429–449 (*June*, 1948).—The first of a series of papers, in which the aim is to find an approx. model of electronic energy bands in Al and to discuss some properties of Al and its alloys. The calculation of the energy levels according to Bloch's approx. of tightly bound electrons is described. In the case of Al, the 3 valence electrons are distributed in the 2 Brillouin zones in such a way that the first zone is nearly full and the Fermi surface lies near the bounding square faces of this zone in the {100}-directions. The second zone is partly filled with one electron and the Fermi surface is semi-ellipsoidal. The soft X-ray emission spectra of Al are discussed. L. S. G.

537.133 : 539.152.1 : 530.14 *see Abstr.* 2330

537.133 : 539.172 *see Abstr.* 2573

537.226 2463

Anomalous effects in hysteresis loops of a single crystal of $BaTiO_3$. DE BRETTEVILLE, A., JR. *Phys. Rev.*, **73**, 807–8 (*April* 1, 1948).—Ferroelectric hysteresis loops have been observed to show transient jumps analogous to the Barkhausen effect in ferromagnetics. A. E. D. B.

537.226.2 : 549.211 2464

Dielectric constant of diamond. BHAGAVANTAM, S., AND NARAYANA RAO, D. A. A. S. *Nature, Lond.*, **161**, 729 (*May* 8, 1948).—The constants for the 2 types of diamond were found by a liquid-mixture method [Abstr. 3529 (1947)]. There is no measurable difference between the two. L. S. G.

537.291 : 538.691 2465

Orbits of charged particles in constant fields. TAUB, A. H. *Phys. Rev.*, **73**, 786–98 (*April* 1, 1948).—Solutions of the relativistic equations of the motion obtained in terms of a Lorentz transformation determined by the tensor describing the field. Explicit expressions for the orbits are obtained. The methods used may be applied to the orbit of a charged particle in the field of a plane wave. These orbits are discussed in detail. A.

537.291 : 621.317.729 = 4 2466

An automatic electron-trajectory tracer. MARVAUD, J. *C.R. Acad. Sci., Paris*, **226**, 476–8 (*Feb.* 9, 1948) *In French.*—[Abstr. 1947 B (1948)].

ELECTRIC CURRENTS 537.3

537.3 + 539.155.2 + 535.214 2467

Recent advances in science. Physics. VICK, F. A. *Sci. Progr.*, **36**, 268–73 (*April*, 1948).—Subjects: Electrical noise (4 pp., 8 refs.) The separation of isotopes in quantity by electromagnetic means (1 p., 1 ref.) Making use of the pressure of light (½ p., 1 ref.)

537.311.3 : 541.135.5 2468

Use of bright platinum electrodes for measurement of electrolytic resistances. CHOUDHURI, K. *Indian J. Phys.*, **22**, 1–6 (*Jan.*, 1948).—Because of difficulties with platinized electrodes, it is desirable to use bright electrodes in measurements of electrolytic resistances. It is shown that the Wheatstone's bridge method gives as satisfactory results with bright electrodes as with platinized electrodes by using a two-electrode cell and (1) an a.c. galvanometer of the wattmeter or of the dynamometer type through an amplifier, (2) a low impressed voltage, (3) a shunted capacitance in the R-arm and by making the ratio arms of equal resistance. A.

537.311.31 : 536.48 2469

The electrical resistance of potassium, tungsten, copper, tin and lead at low temperatures. VAN DEN BERG, G. J. *Commun. K. Onnes Lab., Leiden* (*No.* 274*a*). *Physica, 's Grav.*, **14**, 111–38 (*April*, 1948) *In English.*—Measurements of the resistance of K wires in glass tubes, of single crystals of W, of technical Cu wires, of single crystals of Sn and of Pb wires were made. Matthiessen's rule was found valid for the Cu wires. The "ideal" resistance of K wires and of Sn single crystals follows the formula of Bloch [Abstr. 1449 (1929), 2265 (1930)] below ~10°K. The single crystals of W have an "ideal" resistance, which is a linear function of $T^{3.6}$. The extrapolation of the resistance-temperature curve of Pb by means of measurements in a magnetic field, which disturb the super-conductivity, is not very reliable. A comparison of the calculated "ideal" resistance according to the formula of Gruneisen with the "ideal" resistance, calculated from the measurements between 7 and 90°K, shows large deviations above 20°K. The characteristic temperature, calculated from the measurements above 20°K, is very different from that from the specific heat. A.

537.311.31 : 537.122 2470

"Diffuse scattering" of the Fermi electrons in monovalent metals in relation to their electrical resistivities. BHATIA, A. B., AND KRISHNAN, K. S. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 185–205 (1948).—The main step in the calculation of the electrical resistivities of monovalent metals is the calculation of the relaxation time, τ, of the electrons at the Fermi surface. Since the wavelength λ, and hence the group velocity v, of the Fermi electrons is known, the calculation of τ means also the calculation of the mean free path $l = v\tau$ of these electrons. The finite mean free path of the electrons arises from the scattering in the passage of the electrons through the crystal, by the thermally agitated atoms. A detailed knowledge of the scattering coefficient of the crystal for the Fermi electrons, incident and scattered along different directions in the crystal, will enable one to calculate τ or l. The scattering coefficient depends on two factors: (1) The atom form factor for scattering, which in monovalent metals may be taken to be isotropic, i.e. independent of the direction of incidence or of scattering separately, but dependent on the angle of scattering ϕ between them, and on λ; (2) the structure factor of the crystal, which will vary with the direction of incidence and of scattering, but will be independent of the nature of the waves, i.e. independent of whether they are X-rays, or electron or neutron waves. The mean free path of the

Fermi electrons is calculated in detail for different directions of incidence, for sodium crystal. In Na, and presumably in the other monovalent metals also, the mean free path of the Fermi electrons may be taken roughly as the reciprocal of the attenuation coefficient of the crystal due to scattering, which may be regarded as due almost wholly to the local thermal fluctuations in density; and the Fermi wavelength may be taken as long enough for the Einstein–Smoluchowski formula for density-scattering to be applicable. A.

537.312.62 2471

Penetration of magnetic field into superconductors. I. Measurements on thin cylinders. DÉSIRANT, M., AND SHOENBERG, D. *Proc. Phys. Soc., Lond.*, **60**, 413–24 (*May*, 1948).—Absolute values of the penetration depth, λ, at different temperatures can be obtained from the relative values indicated by measurements on colloids, if $\Delta\lambda$, the difference between λ at a variable and at a fixed temperature, is known. Various methods of measuring $\Delta\lambda$ are reviewed, and an account is given of one particular method in which $\Delta\lambda$ is deduced from the changes of susceptibility of thin cylinders with temperature. The changes found for Hg cylinders were, within experimental error, inversely proportional to the radii as simple theory demands, and the temperature variation was consistent with that to be expected from the colloid results. The absolute value of λ at 0°K is estimated as $7{\cdot}6\times10^{-6}$ cm. In the case of Sn the values of $\Delta\lambda$ measured by the present method were in rough agreement with those of other methods, but since no colloid results were available, the absolute value of λ remains undetermined. The Hg results are discussed also in relation to critical field measurement on thin films. Some preliminary results bearing on the possible dependence of λ on magnetic field are mentioned; it is concluded that λ does not vary appreciably in fields up to half the critical value. A.

537.312.62 2472

The intermediate state of superconductors. I. Magnetization of superconducting cylinders in transverse magnetic fields. DÉSIRANT, M., AND SHOENBERG, D. *Proc. Roy. Soc. A*, **194**, 63–79 (*July* 28, 1948).—The magnetization curves of Sn and Hg cylinders were measured in transverse magnetic fields at a variety of temperatures in the superconducting range, and for various cylinder radii from $1{\cdot}8\times10^{-2}$ to $1{\cdot}7\times10^{-3}$ cm. As the radius was reduced the curve departed more and more from the simple form to be expected for an infinite cylinder of large radius, and the details of the departures agree qualitatively with the predictions of Landau's theory of the intermediate state. The experiments show also that the sharp drop of magnetization corresponding to entry into the intermediate state coincides closely with the appearance of resistance. Detailed comparison with Landau's theory yields estimates of the surface energy at a boundary between normal and superconducting phases at the various temperatures. A.

537.312.62 2473

The intermediate state of superconductors. II. The resistance of cylindrical superconductors in transverse magnetic fields. ANDREW, E. R. *Proc. Roy. Soc. A*, **194**, 80–98 (*July* 28, 1948).—See Abstr 2472 (1948). The resistance of the cylinders was measured between 1·5°K and the superconductivity transition temperature, for cylinder radii from 5×10^{-2} cm to $1{\cdot}3\times10^{-3}$ cm. It was found that the field ρH_c, which first caused the appearance of resistance, and which is well known to be greater than $\frac{1}{2}H_c$, increased with decreasing radius approx. in the manner predicted by Landau's theory. There have been considerable discrepancies between the results of previous workers concerning the temperature-dependence of ρ, and on the basis of the present measurements it was possible to suggest plausible explanations of the discrepancies. It was shown that the resistance and magnetic induction in the intermediate state are closely correlated, as might be expected. Using this correlation in conjunction with the magnetic behaviour predicted on the basis of Landau's theory, estimates are obtained of the surface energy at the boundary between superconducting and normal phases; it is the finite size of this energy which is responsible for the fact that $\rho > \frac{1}{2}$. A.

537.312.62 2474

The intermediate state of superconductors. III. Theory of behaviour of superconducting cylinders in transverse magnetic fields. ANDREW, E. R. *Proc. Roy. Soc. A*, **194**, 98–112 (*July* 28, 1948).—See Abstr. 2473 (1948). The magnetic behaviour is developed for Landau's branching laminar model of the intermediate state, and for a branching thread model. The main features of the magnetization and resistance curves presented in parts I and II receive qualitative explanation, and expressions are derived for quantitative comparison of experiment with theory. A.

537.312.9 2475

Influence of pressure on the resistance of goldsilver alloys. MICHELS, A., AND WASSENAAR, T. *Physica, 's Grav.*, **14**, 61–2 (*April*, 1948) *In English.*—The electrical resistance was measured as a function of pressure, up to 2 800 atmos. at 25 and 60°C. Pressure coefficients were calculated between 1 and 2 600 atmos. Residual resistances at −78°C, −183°C and −196°C were also measured. Results obtained by extrapolating to −273·15°C are given.

537.322 : 538.639 2476

The theory of the galvanomagnetic and thermomagnetic effect in metals. SONDHEIMER, E. H. *Proc. Roy. Soc. A*, **193**, 484–512 (*July* 21, 1948).—The methods of a previous paper [Abstr. 2901 (1947)] are used to discuss the effect of a magnetic field on the thermoelectric power of a metal containing two overlapping energy bands of normal form. Exact solutions of the transport equation are obtained for the three limiting cases of high temperatures, low temperatures and very strong magnetic fields, and it is shown that the formulae can be generalized to give approximate expressions for all temperatures and all fields. The magnetic change of the thermoelectric power is found to be small at very low and high temperatures, and to pass through a maximum at intermediate temperatures. The transverse galvano- and thermomagnetic effects are considered, and formulae which hold for free electrons are generalized so as to be approx. valid for all temperatures. For free electrons, the Hall coefficient remains constant as the temperature decreases, the Righi–Leduc coefficient increases, and the Ettingshausen and Ettingshausen–Nernst coefficients decrease and change sign at very low temperatures. The corresponding formulae for a metal containing two bands are also obtained, and are used to show that the theoretical predictions for free electrons cannot hold for real metals except in special cases. The two-band model is used to discuss the effect of the magnitude of the magnetic field on the coefficients of the transverse effects. A

537.36 : 532.13 *see Abstr.* 2364–5

ELECTRIC DISCHARGES AND RADIATIONS 537.5

537.52 247

The production of high velocity mercury vapor jets by spark discharge. HAYNES, J. R. *Phys. Rev.*, **73**, 891–90

(*April* 15, 1948).—Photographs of sparks of microsecond duration in H_2 to a Hg electrode show high velocity jets from the Hg surface regardless of polarity. Spectroscopic examination shows that these jets are largely composed of Hg atoms which sweep away the H_2. Measurements of jet velocity demonstrate that it is independent of current and gas pressure over a wide range. While it decreases with distance from the source, the original velocity of the cathode jet is $1 \cdot 9 \times 10^5$ cm/sec, and that of the anode jet is $1 \cdot 5 \times 10^5$ cm/sec. The energy of the anode jet can be accounted for by positive Hg ions crossing the anode drop. It appears that the energy of the cathode jet cannot be accounted for unless it is assumed that, in addition to positive ions striking the cathode and rebounding as neutral atoms, many Hg atoms leave the cathode as negative ions. A.

537.52 2478

The rate of growth of current and the behaviour of the cathode spot in transient arc discharges. FROOME, K. D. *Proc. Phys. Soc., Lond.*, **60**, 424–35 (*May*, 1948).—The factors are discussed which control the initial rate of increase of current in the discharge obtained when a capacitor of several microfarads is discharged through a small tube containing rarefied gas. It is suggested that at higher pressures ionization probably proceeds "thermally," but that at lower pressures ionization takes place by direct electron collision, the cathode spot having a negligible retarding effect except possibly at very low pressures. The current density of emission from the cathode spot is at all times enormous, appearing sometimes greater than 10^6 A/cm², and very seldom less than 10^5 A/cm² even for a discharge prolonged until it has the appearance of a normal arc. It is suggested, therefore, that the value [Abstr. 1641 B (1940)] of the emission current density of about 10^4 A/cm² usually accepted for normal vacuum arcs is in error [Abstr. 633 (1947), 1321 (1946)]. The rapid movement of the cathode spot and rate of growth of current exclude the possibility of the cathode emission being derived thermionically, while the very high current densities observed favour field emission. A.

537.521.6.029.6 2479

The breakdown of gases in high frequency electrical fields. HALE, D. H. *Phys. Rev.*, **73**, 1046–52 (*May* 1, 1948).—A theory of the breakdown is proposed. It is assumed that breakdown occurs when the electrical field and the frequency are such that an electron acquires the ionizing energy at the end of one mean free path. The field for breakdown is thus a function of the frequency of the applied potential and the ionization potential and pressure of the gas. The fields for breakdown of A and Xe are calculated and expressed as functions of the frequency and the gas pressure. The calculated potentials are compared with experimental data, and good agreement is found for frequencies greater than 10 Mc/s. A.

537.521.6.029.6 : 621.3.015.5.029.6 2480

Electrical breakdown strength of air at ultra high-frequencies. PIM, J. A. *Nature, Lond.*, **161**, 683–4 (*May* 1, 1948).—Measurements were made from 100–300 Mc/s with a continuous-wave source of power, and a dielectric voltmeter calibrated from a 50 c/s source, depending on the uniform permittivity of "Distrene" from 0–1 000 Mc/s. Discontinuities were found in the (breakdown stress)/(gap width) curves which indicate that, with a field of a particular frequency, some charged particles (probably electrons) are unable to cross the gap before the field is reversed.

537.521.7.029.6 : 621.3.015.5.029.6 2481

Erratum: The microwave spark. POSIN, D. Q. *Phys. Rev.*, **73**, 1118 (*May* 1, 1948).—Abstr. 1859 (1948).

537.529 2482

On the electric breakdown of solid dielectrics. KELLER, K. J. *Physica, 's Grav.*, **14**, 15–16 (*Jan.*, 1948). *In English*—The theory of Fröhlich [Abstr. 1341 B (1941); 3411 (1939)] is satisfactorily linked with experimental results of Von Hippel and Lee [Abstr. 1658 (1941)].

537.529 : 548.0 2483

Breakdown directions in lithium halide crystals. DAVISSON, J. W. *Phys. Rev.*, **73**, 1194–1200 (*May* 15, 1948).—Electrical breakdown paths in the Li halide crystals form star patterns consisting of 12 paths of the type $[xxy]$ where $x \geqslant y$. The paths lie within the acute sectors of the (110) planes bounded by the directions [110] and [111]. The star assumes the [110] orientation at low temperatures and tends to approach the [111] position as the temperature increases. Under overvoltage conditions, complex $[xxy]$ patterns are obtained; they show abrupt changes in orientation as the paths proceed through the crystal, but follow a definite sequence of directions. Although the breakdown paths seem to mark those directions in which electrons can be accelerated most rapidly to the ionization potential of the lattice, the star paths apparently do not follow simply from an electron wave interaction with the lattice or from a statistical competition between breakdown in the [110] and [111] directions. A.

537.531 : 535.2 2484

Intensity measurements in the very soft X-ray region. CHALKLIN, F. C. *Proc. Roy. Soc. A*, **194**, 42–62 (*July* 28, 1948).—In the grazing incidence grating spectroscopy of the soft X-ray region, it is customary to measure the intensity distribution in the emission bands from solids by methods involving the assumption of the photographic reciprocity law. A procedure was evolved by which this assumption is avoided. An account is given of the experimental technique and of the essential precautions. Characteristic blackening curves were obtained for the photographic plates in the soft X-ray region and under the actual conditions of spectroscopy. Intensity distribution curves were obtained for the *K* emission bands of graphite, lampblack, diamond and carborundum. The emission band of lampblack is similar to that of graphite but is somewhat wider. The difference between the present curves and those previously obtained appears most clearly in diamond and carborundum. The energy distribution of the *p* electrons in the valence bands of the solids is calculable from the curves. A.

537.531 : 535.34 2485

On the empty electron bands of lowest energy of the transition metals Mn and Fe and their oxides. COSTER, D., AND KIESTRA, S. *Physica, 's Grav.*, **14**, 175–88 (*April*, 1948) *In English*.—The X-ray *K*-absorption spectra of Fe and Mn were investigated using the photographic method. Results are equivalent to those obtained by Beeman and Friedman with the double X-ray spectrometer [Abstr. 4075 (1939)]. The initial absorption jump found on the long wavelength-side of the edge of the transition metals is attributed to a transition of the *K*-electron into an empty state of the 4*s*-band having *p*-character. The intensity of the corresponding absorption and the conductivity of the metal in question increase with varying atomic number in the same direction. The X-ray absorption spectra were also photographed, when the metals were present in one of their various oxides. These spectra have much in common with the absorption spectrum of the corresponding metal; the initial jump referred to above is much weaker. The spectrum of Zn when forming part of ZnO was photographed. It is nearly identical with that of metallic Zn. A.

537.531 : 535.43 2486

A correction for the $\alpha_1\alpha_2$ doublet in the measurement of widths of X-ray diffraction lines. RACHINGER, W. A. *J. Sci. Instrum. Phys. Ind.*, **25**, 254–5 (*July*, 1948).

537.531 : 539.11 : 537.122 *see Abstr.* 2462

537.533.1 : 530.145.6 *see Abstr.* 2351

537.533.72 : 539.163.2 2487

A magnetic lens beta- and gamma-ray spectrometer. QUADE, E. A., AND HALLIDAY, D. *Rev. Sci. Instrum.*, **19**, 234–9 (*April*, 1948).—New features include (*a*) alignment with the earth's magnetic field to eliminate the deflection of the focal spot by this field; (*b*) use of a segmented coil to achieve a substantial reduction in spherical aberration; and (*c*) use of cathode rays for alignment, calibration, and for measurement of the aberration. Automatic operation was achieved. Special attention was given to the effects of source backing and to focusing conditions for electrons in the very low energy region. A.

537.533.72 : 539.165.08 *see Abstr.* 2551

537.533.8 2488

Secondary electron emission from targets of barium-strontium oxide. JOHNSON, J. B. *Phys. Rev.*, **73**, 1058–73 (*May* 1, 1948).—The yield, δ, of (BaSr)O, was studied, as induced by microsecond pulses of primary electrons with energy up to 2 000 eV. The δ/V_p curves have the usual form, with maximum δ near 1 200 eV. At room temperature, and before surface charges build up, the δ_{max} is of the order 12, but it may be reduced to 6 by less than 0·1 atomic layer of Ba evaporated from a nearby thermionic cathode. With increasing temperature, δ decreases to an apparent minimum at $\sim$600°C. With the onset of d.c. thermionic emission the total yield increases during each pulse, in rough proportion to the thermionic current. The increase is thought to represent a transient change in thermionic activity caused by the bombardment. No change with temperature is observed for the energy distribution of the true secondaries. The possibility of field-enhanced secondary emission at low temperatures is considered. A.

537.534.74 : 517.9 : 539.152.1 *see Abstr.* 2526

537.534.74 : 539.152.1 *see Abstr.* 2523–5

537.534.74 : 539.185 *see Abstr.* 2590

537.534.74 : 539.185 : 539.152.1 *see Abstr.* 2527–8

537.542 : 539.16.08 2489

Particle and quantum counters. CORSON, D. R., AND WILSON, R. R. *Rev. Sci. Instrum.*, **19**, 207–33 (*April*, 1948).—A review of the operating mechanism and special properties of the commonly used counters, intended for those interested in counting techniques who have not had first-hand experience with all the various counters. Discussion of calibration and measurement techniques is omitted. 19 figs., 96 refs. A.

537.56 2490

A positive ion source. BAYLY, A. J., AND WARD, A. G. *Canad. J. Res.*, *A*, **26**, 69–78 (*March*, 1948).—Positive ions are formed in a low-pressure electrodeless discharge which is excited by the r.f. field of a coil coupled to a 15 Mc/s oscillator. The ions are extracted from the discharge through a pumping canal (2 mm in diameter × 12 mm in length) by a simple arrangement of electrodes. After further focusing and acceleration to 50 kV, the beam current at the target is 500 μA, and the focal spot is 6 mm in diameter. Magnetic analysis has shown that the beam consists of 50% protons when using hydrogen in the discharge and 60% deuterons when using deuterium. Gas is supplied to the source at the rate of 15 cm³/hr. A.

537.56 : 531.19 : 523.877 = 3 2491

On the calculation of partition functions for atoms and ions in a partly ionized gas. UNSÖLD, A. *Z. Astrophys.*, **24** (*Nos* 3–4) 355–62 (1948) *In German.*—Planck's theory of thermal excitation and ionization is reconsidered and expressed in a form suitable for calculations. The relation of this theory to that of Urey and Fermi is discussed. R. A. N.

537.582 : 539.164.8 *see Abstr.* 2549

COSMIC RAYS 537.591

537.591 2492

Why are we studying cosmic rays? BRADT, H. L. *Experientia*, **4** (*No.* 2) 41–56 (1948) *In English.*—Indicates the position of cosmic rays in physics, and summarizes the main lines of work to date. (15 illustrations, short bibliography.) J. G. W.

537.591 : 530.145 *see Abstr.* 2344

537.591 : 539.17 *see Abstr.* 2567

537.591 : 539.18 2493

Generation of mesons and its dependence on meson spin. CHAKRABARTY, S. K. *Bull. Calcutta Math. Soc.*, **39**, 166–76 (*Dec.*, 1947).—Approx. expressions for the cross-sections for different processes are obtained, both for transverse and pseudoscalar mesons. These are used in calculations of (1) the energy spectrum of nucleons at different levels of the atmosphere, (2) the energy spectrum of mesons produced by primary protons of different energies, and (3) the integral spectrum of mesons at various levels. (1) differs considerably from that obtained by Peng [Abstr. 2053 (1944)]. Reasons for this are advanced. (2) is nearly similar, but the numbers of mesons in different energy regions are larger by a factor of 2 to 3 if the mesons are transverse than if they are pseudoscalar. This fact can be used to ascertain the spin of sea-level mesons only if the intensity as well as the energy spectrum of the primary protons are accurately known. The energy spectrum depends critically on the proper lifetime, τ, of the meson at rest. Comparison of present results with observed results of Wilson [Abstr. 3170 (1946)] show that $\tau \simeq 2{\cdot}7 \times 10^{-6}$ sec. The observed knee of the latitude effect can be explained whether the mesons are transverse or pseudoscalar. L. S. G.

537.591.1 2494

The production of nucleons by the cosmic radiation. II. KORFF, S. A., AND COBAS, A. *Phys. Rev.*, **73**, 1010–14 (*May* 1, 1948).—For previous work see Abstr. 2592 (1947). A series of experiments at high elevations is described. Balloon flights reaching altitudes corresponding to a pressure of 2 cm Hg were carried out. No maximum in the neutron counting rate was found. The effect produced by surrounding by water a counter near the ground was found to be small, indicating that most of the neutrons were already slow. No diurnal effect as large as 10% in the neutrons was found at a level of 6 metres of water equivalent. A.

537.591.15 2495

Extensive penetrating showers. CHAUDHURI, B. *Nature, Lond.*, **161**, 680 (*May* 1, 1948).—Extensive showers selected by a counter array were used to trigger a cloud chamber, which thus gave a density sample of the showers; at the same time, coincidences with a heavily shielded counter tray were indicated. The results of over 1 400 photographs are tabulated and comparison made with formulae (*a*) derived from the density spectrum of extensive showers [Abstr. 909–10 (1947)], (*b*) based on the assumption that the occurrence of a penetrating

count in any region of an extensive shower $\propto$ the particle density in that region. The agreement is good.

537.591.5 2496

Measurements on the east-west asymmetry of cosmic-rays at Lahore, India (22° N). SHARMA, O. P., AND SARNA, H. R. *Indian J. Phys.*, **22**, 19–26 (*Jan.*, 1948).—A triple-coincidence counter telescope was employed for a study of the east-west asymmetry. Each G.M. tube consisted of a 0·194-mm dia. Ni wire anode and an oxidized cylindrical Cu cathode, 0·25 mm thick, 2·5 cm in dia. and 35 cm in length, sealed in a pyrex glass tube. The counters were filled with ethyl alcohol and argon mixture to a total pressure of 11 cm of Hg. The telescope was mounted on a light wooden frame capable of rotation about horizontal as well as vertical axes, the angles being read accurate to 0·25° by pointers moving on graduated circular scales. Asymmetry measurements were made for a number of zenith angles. The maximum asymmetry occurs at 30° with respect to the zenith. The results were compared with those of other observers, and it was suggested that the small apparent divergences might be due to differences in the angular cones subtended by the telescopes used by different observers. A.

537.591.5 2497

The semi-diurnal variation in cosmic ray intensity. NICOLSON, P., AND SARABHAI, V. *Proc. Phys. Soc., Lond.*, **60**, 509–23 (*June*, 1948).—The experimental data on the daily variation in cosmic-ray intensity are surveyed. It appears to be established by Rau's experiments [*Z. Phys.*, **114**, 265 (1939), Abstr. 687 (1940)] that the energetic meson component at sea level shows a marked semi-diurnal variation which is in phase with the semi-diurnal variation shown by the barometric pressure. Several authors have suggested that this phenomenon is explicable in terms of the Pekeris theory of atmospheric oscillations. The implications of this explanation on the process of meson formation are examined quantitatively. It is concluded that the explanation is only possible if mesons arise mainly at about 60 or 70 km above sea level, which is highly unlikely, since the corresponding cross-section for meson production would be much larger than appears plausible. The experimental data on the diurnal variation are briefly discussed. This variation seems to be more complicated in character than is usually assumed, and not attributable to factors such as a heliomagnetic field and fluctuations in the geomagnetic field. A.

537.591.5.08 2498

Directional counter for the determination of the complete azimuthal effect of primary cosmic radiation. BAÑOS, A., JR., AND PERUSQUÍA, M. L. *Rev. Sci. Instrum.*, **19**, 239–43 (*April*, 1948).—The apparatus consists essentially of four triple-coincidence G.M. telescopes, mounted at zenith angles of 0°, 20°, 40°, and 60°, and so arranged that, by rotation around a vertical axis, the directional intensity or counting rate can be measured at 16 equally spaced azimuths. The rotation and photographic recording are fully automatic Several novel features of the apparatus are discussed. Instead of the usual parallel connection of the three counters, as in the conventional Rossi circuit and necessitating an amplifier tube for each counter, a material simplification of the circuits was obtained by connecting the three counters in series feeding a single stage of amplification. A.

MAGNETISM 538

538 : 530.12 *see Abstr.* 2320–1

538.083.9 : 538.632 : 621.317.4 2499

A magnetic field strength meter employing the Hall effect in germanium. PEARSON, G. L. *Rev. Sci. Instrum.*, **19**, 263–5 (*April*, 1948).—The essential parts of the instrument include a small Ge probe, and a panel type micro-ammeter calibrated directly in gauss. Its accuracy is ±2% at fields between 100 and 8 000 gauss. At higher fields the readings are too low, the error amounting to 9% at 20 000 gauss. The chief advantages of this instrument are: (*a*) small size and portability, (*b*) continuous reading rather than ballistic as in ordinary field strength meters, and (*c*) a small non-magnetic probe with which one can search in very narrow gaps. A.

538.114 : 539.215.4 2500

Domain theory and the dependence of the coercive force of fine ferromagnetic powders on particle size. KITTEL, C. *Phys. Rev.*, **73**, 810–11 (*April* 1, 1948).—The observed values of coercive force of fine powders are shown to be in fair agreement with domain theory. A. E. De B.

538.122 : 621.384.6 : 621.318.33 2501

A note on the shape of the polepieces of a synchrotron magnet. DAVY, N. *Proc. Phys. Soc., Lond.*, **60**, 598–9 (*June*, 1948).—Calculation of the shape to give a magnetic field of the form $H = ar^{-\frac{1}{3}}$ is described (r = radius vector from centre of ring magnet to point in centre plane of gap; H along the radius).

538.123.081 = 3 2502

Magnetic potential and magnetic field strength, definitions, magnitudes, units, equations, examples of calculations, principles of measurement. NEUMANN, H. *Arch. tech. Messen, Issue* 152 (*Ref.* 390–1) *T*8–9 (*July*, 1947) *In German.*—The usual definition of magnetic field strength using unit poles has been abandoned since it is impossible to make it a basis of physical measurement. New definitions are given for the magnetic potential, which has the dimension of a current. Magnetic field strength and magnetomotive force are considered. The relation between practical and absolute magnetic units is given. The field due to an air-cored electromagnet, an iron-cored electromagnet, and a permanent magnet is calculated. The basis of magnetic potential and field strength measurement is the flux density in a narrow slit parallel and transversely to the direction of magnetization. V. W. R.

538.213.029.6 2503

High-frequency permeability. SMIDT, J. *Appl. Sci. Res.*, **B 1** (*No.* 2) 127–34 (1948).—The permeability of Fe was determined in the region between 360 and 580 Mc/s (83 and 52 cm) by observing the decrease in the wavelength measured on a coaxial line, having an Fe wire as inner conductor, compared with the wavelength measured on a similar non-ferro-magnetic system, using the same frequency. The Fe contained Mn, Ni, Cr and C impurities. A rapid falling off of the permeability to the value 1 was found. The temperature and treatment of the wire were found to influence the critical frequency at which this took place. The experimental curve of the permeability plotted against the frequency is compared with some theoretical ones. A.

538.214 : 536.48 : 548.7 2504

On the anisotropic exchange interaction and the behaviour of copper potassium sulphate at very low temperatures. OPECHOWSKI, W. *Physica, 's Grav.*, **14**, 237–48 (*May*, 1948) *In English.*—Formulae are given for the specific heat and the magnetic susceptibility of a crystal, calculated on the assumption that the interaction between magnetic atoms is a sum of the anisotropic (direct or indirect) exchange interaction and the magnetic interaction. These formulae are applied to the case of CuK sulphate which were previously investigated experimentally at temperatures $<1°$K [Abstr. 920 (1947)]. No unambiguous theoretical conclusions seem possible. A.

538.22 : 666 2505

Magnetic susceptibility of borax glasses containing crystallites of alkali metal salts, gold and platinum. MAJUMDAR, S. K. *Nature, Lond.*, **161**, 684–5 (*May* 1, 1948).

538.222 : 536.5.081 : 536.48 *see Abstr.* 2451

538.249 2506

Dispersion and absorption in magnetic ferrites at frequencies above one Mc/s. SNOEK, J. L. *Physica, 's Grav.*, **14**, 207–17 (*May*, 1948) *In English.*—The absorption and dispersion are discussed on the assumption that at these frequencies no contribution to the magnetization is made by the Bloch boundaries. For pure and unstrained polycrystalline aggregates of cubic crystals the relation between the critical frequency ω_0 and the initial susceptibility χ is found to be $\omega_0 . \chi = 3/2|g|M$, where $g = e/mc = 1{\cdot}76\times10^6$ and M is the magnetic moment/cm³. In deriving this equation the damping is assumed to be small. It is further shown that internal stresses tend to increase the losses at lower frequencies and make the rise in $\tan\delta$ with frequency less steep. This is verified by experiment. A.

538.27 2507

Some remarks on the dispersion of the ferromagnetic permeability. VAN LEEUWEN, H. J. *Appl. Sci. Res.*, **B 1** (*No.* 2) 135–8 (1948).—A comparison of various theoretical interpretations of the decrease of the reversible ferromagnetic permeability with increasing frequency is made. The theory cannot yet give the exact relation of permeability and frequency, but only gives the frequency region of the dm waves as that where the permeability decreases. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.145 *see Abstr.* 2345

538.3 : 530.145.1 *see Abstr.* 2348

538.312 : 538.566 = 396 2508

On the electromagnetic field. MUUR, S. *Elektrotek. Tidsskr.*, **61**, 158–62 (*April* 25, 1948) *In Norwegian.*—The magnetic vector potential, A, defined by the equation $\nabla\times A = H$, satisfies the general wave motion equation. This is proved by employing the above equation along with the usual Maxwell field equations. An alternative method is obtained by regarding A as a generalized co-ordinate defining the condition of the field at each point. Expressions for T, the electrical energy, and V, the magnetic energy in the field, are formed in terms of A and A. By employing these expressions to represent kinetic energy and potential energy respectively in accordance with Lagrange's dynamical method the wave equation is again obtained as the fundamental equation for determining the vector A. G. G.

538.5/.6 + 535.8 + 531.7 *see Abstr.* 2359

538.56 : 621.317.729 : 621.396.671 2509

Field distributions near a centre-fed half-wave radiating slot. PUTMAN, J. L., RUSSELL, B., AND WALKINSHAW, W. *J. Instn Elect. Engrs, Pt III*, **95**, 282–9 (*July*, 1948).—[Abstr. 2043 B (1948)].

538.56 : 621.396.671 2510

Input impedances of centre-fed slot aerials near half-wave resonance. PUTMAN, J. L. *J. Instn Elect. Engrs, Pt III*, **95**, 290–4 (*July*, 1948).—[Abstr. 2044 B (1948)].

538.566 : 538.312 = 396 *see Abstr.* 2508

538.566 : 551.510.535 : 621.396.11 2511

A study of the interaction of radio waves. RATCLIFFE, J. A., AND SHAW, I. J. *Proc. Roy. Soc. A*, **193**, 311–43 (*July* 2, 1948).—Experiments are described in which the interaction is used to provide information about the height at which radio waves of different frequencies are absorbed in the ionosphere. It is first demonstrated by two crucial experiments that the absorption mechanism suggested by Bailey and Martyn [*Nature*, **133**, 218 (1934), Abstr. 4172 (1934)] is the true one. Measurements of the phase of the modulation transferred from one wave to the other by the non-linear absorption process in the ionosphere are described; by measuring this phase at different modulation frequencies, it is possible to locate the region where the interaction occurs. The results of a series of experiments are discussed. The conclusion is reached that the frequency with which electrons collide with neutral molecules at a height of about 85 km is of the order $5\times10^5\ \text{sec}^{-1}$, and that this is the height near which the main absorption of waves of frequency 1 Mc/s and 200 kc/s are absorbed at night. Waves of frequency 90 and 68 kc/s are absorbed, and possibly also reflected, below this level. With the approach of dawn the regions responsible for absorbing 1 Mc/s and 200 kc/s waves drift apart. The theory of Bailey and Martyn is related to modern theories of ionospheric absorption and is restated with the standard nomenclature of Appleton's magneto-ionic theory. A.

MAGNETIC EFFECTS 538.6

538.61 : 541.182.6 2512

Optical transmission of a colloidal solution in a magnetic field. STOTT, F. D., AND VON ENGEL, A. *Nature, Lond.*, **161**, 728–9 (*May* 8, 1948).—A brief account of the changes in the transmission as a function of the field strength; theoretical and experimental. L. S. G.

538.61.08 2513

Apparatus for the measurement of the Faraday effect. BROERSMA, S. *Appl. Sci. Res.*, **B 1** (*No.* 2) 143–8 (1948).—With a view to the statistical analysis of mixtures of hydrocarbons a compensation method for the measurement of the Verdet constant is developed. Some details concerning the field coils and their arrangement are given. The advantages of the compensation system are sketched. The applicability of an objective method was checked. A.

538.615 : 535.337 *see Abstr.* 2414

538.632 : 621.317.4 : 538.083.9 *see Abstr.* 2419

538.639 : 537.322 *see Abstr.* 2476

538.691 : 537.291 *see Abstr.* 2465

ATOMIC AND MOLECULAR STRUCTURE 539

539.11 : 537.531 : 537.122 *see Abstr.* 2462

539.13 : 519.214 *see Abstr.* 2304

539.13 : 535.343.4–14 *see Abstr.* 2423

539.132 : 530.145 *see Abstr.* 2333

539.132 : 535.343.4–14 *see Abstr.* 2424–5

539.132 : 541.57 2514

The electronic structure of conjugated systems. III. Bond orders in unsaturated molecules. IV. Force constants and interaction constants in unsaturated hydrocarbons. COULSON, C. A., AND LONGUET-HIGGINS, H. C. *Proc. Roy. Soc. A*, **193**, 447–64 (*July* 21, 1948).—III. The changes in bond order that take place in a conjugated system when the resonance integral of a bond, or the Coulomb term of an atom is altered are studied. It is shown that the sign of the mutual polarizability of two bonds in a chain depends upon whether there is an even or odd number of other bonds between them. Numerical values

are given for mutual bond polarizabilities in some important hydrocarbons, and it is found that in the polyenes the effect of a perturbation decreases rapidly with distance along the chain. The effect of hetero-substitution on bond orders is considered, and the results compared with the predictions of the qualitative resonance theory. IV. The force constant of a bond in a conjugated system depends upon its "self-polarizability" as well as upon its mobile order, and the interaction constant between a pair of bonds is closely related to their "mutual polarizability." The theory is applied to benzene, where good agreement is found with the scanty evidence available, and to naphthalene and butadiene, for which at present the force constants are not known. A.

539.133 : 535.338.4 *see Abstr.* 2415

539.15 : 53.081.6 2515

Our knowledge of the atomic constants *F*, *N*, *m* and *h* in 1947, and of other constants derivable therefrom. DuMond, J. W. M., and Cohen, E. R. *Rev. Mod. Phys.*, **20**, 82–108 (*Jan.*, 1948).—Least-squares methods are applied systematically to obtain solutions of the observational equations derived from measurements of various physical quantities. In these solutions, F and N are treated as independent unknowns—a departure from earlier determinations in which $e = F/N$ was taken as a single datum. The chief change occasioned by the new treatment is an increase of F. A. P. F.

539.152.1 2516

Energy levels of light nuclei. Hornyak, W. F., and Lauritsen, T. *Rev. Mod. Phys.*, **20**, 191–227 (*Jan.*, 1948).—An up-to-date collection of data is presented, covering nuclei between Li^7 and Ne^{20}. For each nucleus a level diagram is given, showing modes of formation and modes of decay in the various energy states. A copious list of references is appended. A. P. F.

539.152.1 2517

A note on the calculation of the spacing of energy levels in a heavy nucleus. Sneddon, I. N., and Touschek, B. F. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 391–403 (1948).—It is assumed that the nucleus consists of neutrons and protons, independent of one another, i.e. a neutron gas in equilibrium with a proton-gas. Fermi–Dirac statistics is applied to each. It is shown that Bethe's formula [Abstr. 4435 (1936)] for the average spacing of the levels may be obtained more simply by using the fact that in a nucleus whose equilibrium state is defined by a single parameter, say the energy Q, $\exp\{-\beta F(\beta)\}$ is the Laplace transform of the density of the energy levels, if the temperature of the nucleus is $1/\beta$ and its free energy is $F(\beta)$. Thus, by inversion, the density may be obtained, when $F(\beta)$ is known. The method is also applied to Wilson's spherical shell model of the nucleus [*Phys. Rev.*, **69**, 538 (1946)], and to a nuclear model consisting of a spherical core of neutrons surrounded by a spherical shell of protons. L. S. G.

539.152.1 2518

Collisions of neutrons and protons with deutrons and the nature of nuclear forces. Massey, H. S. W., and Buckingham, R. A. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 175–7 (1948).—A short review of work in progress based on the author's earlier paper [Abstr. 2721 (1941)].

539.152.1 : 530.14 *see Abstr.* 2329

539.152.1 : 530.145 2519

The two-nucleon problem. Rosenfeld, L. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 133–42 (1948).—This review of calculations on the deuteron in recent years compares and assesses the different methods of treating central and non-central forces, using either empirical force fields or meson theories of various types, with weak or strong coupling. G. J. K.

539.152.1 : 530.145 2520

Strong-coupling meson theories. Wentzel, G. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 143–50 (1948).—Results obtained either for the excited states and magnetic moment of a single nucleon, or for the nuclear forces and the deuteron, suggest that the strong coupling assumption is not very useful. G. J. K.

539.152.1 : 530.145.6 2521

A quantitative discussion of the interaction between nuclear particles. Fröhlich, H., Ramsay, W. H., and Sneddon, I. N. *Rep. Internal. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 166–75 (1948).—See Abstr. 3278 (1947).

539.152.1 : 535.338.42 2522

Electric quadrupole coupling of the nuclear spin with the rotation of a polar diatomic molecule in an external electric field. Fano, U. *J. Res. Nat. Bur. Stand., Wash.*, **40**, 215–23 (*March*, 1948).—Formulae are given which determine the hyperfine spectrum of a rotating molecule in various cases, depending on the external field strength and on the rotational quantum number. A complete calculation is carried out for the case in which only one of the nuclei has a quadrupole moment; the molecule is in a rotational state ($1 : \pm 1$ or 0), and the interaction between the field and the molecular dipole is comparable to that between the dipole and the nuclear spin. A.

539.152.1 : 537.133 : 530.14 *see Abstr.* 2330

539.152.1 : 537.534.74 2523

The scattering of protons by protons and the meson field of the proton. Lubanski, J. K., and de Jager, C. *Physica, 's Grav.*, **14**, 8–14 (*Jan.*, 1948) *In English.*—New calculations are reported on the p–p scattering with several values of the potential energy of the proton, this energy being assumed to be the meson potential. The results of these calculations are compared with available experimental material. They indicate a rather high value for the meson mass to be connected with the potential field of the proton ($M_{max} = 300\,m_e \pm 30\,m_e$). This is in accordance with former calculations [Abstr. 5329 (1936)] and in disagreement with direct determinations of the mass of the meson, this being about $220\,m_e$. A.

539.152.1 : 537.534.74 2524

Sensitivity of proton-proton scattering to potentials at different distances. Breit, G., Broyles, A. A., and Hull, M. H. *Phys. Rev.*, **73**, 869–76 (*April* 15, 1948).—Estimates are made of sensitivity of p–p scattering to assumed changes δV in theoretical potential energy. The energy range 0·15–9 MeV is considered for the incident protons. The changes in potential energy are taken to be small additions in small intervals at distance R. First-order perturbation theory is used. Combining the effect of δV at $R = 3$ or 5 in units e^2/mc^2 with a change δD in the depth of a square potential well, the effects are made to neutralize at a preassigned energy E_{I} and the sensitivity of scattering to δV is estimated at a second energy E_{II}. Combination of these effects with a simultaneous change δr_0 in range of square well enables neutralization of effects at energies E_{I}, E_{II} and adjustment to arbitrary small change in scattering at a third energy E. The sensitivity of observed scattering to δV for a few choices of pairs E_{I}, E_{II} is worked out as a function of E. The region 200 keV–600 keV should be valuable in deter-

mining values of δV for preassigned R. The relative importance of the smaller energies increases with R on account of shielding of the smaller R by the Coulomb barrier. Neutralization of effects at two energies E_I, E_{II}, with simultaneous adjustment to changes in scattering at energies E_1, E_2, is also considered in terms of simultaneous potential energy changes at two values of R combined with δr_0, δD. An experimental accuracy of 1% in scattering is found to correspond to the possibility of detecting as little as 1 keV for δV through a distance e^2/mc^2 at $R = 5e^2/mc^2$ and 10 keV at $R = 3e^2/mc^2$. A.

539.152.1 : 537.534.74 2525

On the scattering of protons by protons. RAMSEY, W. H. *Proc. Roy. Soc. A*, **194** (*No.* 1037) 228–37 (1948).—The features of the *p–p* scattering are calculated using the M–R version of the meson theory of nuclear forces. A comparison with experiment suggests that the *n–p* interaction is slightly stronger than that between two protons. The predictions of the theory fit the experimental results best when the meson mass is assumed to be ~ 270 electronic masses. This is significantly $>$ that indicated by cosmic-ray measurements, and it is also $>$ the values found by using the theory to calculate the features of *n–p* scattering and the binding energies of the lightest nuclei. A.

539.152.1 : 537.534.74 : 517.9 2526

On the solution of scattering and related problems. FERRETTI, B., AND KROOK, M. *Proc. Phys. Soc., Lond.*, **60**, 481–90 (*May* 1, 1948).—A method is presented for solving scattering and eigenvalue problems. This is of use mainly in cases where the forces are of short range. The method is based on a Taylor expansion of the radial eigenfunctions about a point where the potential is already rather small. A procedure is given for determining the logarithmic derivative at this point of the solution which is "least singular" at the origin, this is in general the physically admissible solution. A.

539.152.1 : 537.534.74 : 539.185 2527

Elastic and inelastic scattering of 100- to 200-Mev protons or neutrons by deuterons. WU, T.-Y., AND ASHKIN, J. *Phys. Rev.*, **73**, 986–1001 (*May* 1, 1948).—Expressions are obtained, on the Born approximation, for the elastic and the total scattering cross-section of protons or neutrons by deuterons, on the basis of the three forms of nucleon potentials suggested by Rarita and Schwinger [Abstr. 1356 (1941)], including tensor forces but with a Gaussian function for the radial part $V(r)$. Numerical calculations are carried through without tensor forces for (i) the angular distribution and total cross-section of elastic scattering at 100, 150 and 200 MeV, (ii) the energy spectrum of protons scattered in different directions from that of the incident protons and total cross-section, and (iii) the energy spectra of neutrons ejected in directions making angles 0° and 30° with the direction of the incident protons, for 200 MeV. The three potentials predict considerable differences in both the differential and the total cross-sections for both elastic and total scattering. The *p–d* total cross-sections for 100 MeV is $0{\cdot}424, 0{\cdot}212, 0{\cdot}089 \times 10^{-24}$ cm^2 according to the ordinary, exchange, and symmetrical force, respectively, as compared with the observed value $0{\cdot}117 \times 10^{-24}$ recently reported from Berkeley for 90 MeV. The calculations show that the interference of the amplitudes scattered by the two particles of the deuteron plays an important role in the determination of the total cross-section for *p–d* scattering. It is therefore not a good approximation to set the total *p–d* cross-section equal to the sum of the *p–n* and *p–p* cross-sections for free particle collisions. A.

539.152.1 : 539.185 : 537.534.74 2528

Neutron-proton and proton-proton scattering at high energies. ASHKIN, J., AND WU, T.-Y. *Phys. Rev.*, 73, 973–85 (*May* 1, 1948).—The tensor force was taken into account in calculating the *n-p* and *p-p* scattering at energies in the range from 100 to 200 MeV. Most of the calculations were performed in the Born approximation using a square well potential and the exchange models of Rarita and Schwinger [Abstr. 1356 (1941)]. The rigorous scattering theory was applied to the *n-p* scattering with the symmetrical force model at 100 and 200 MeV. The results show that the Born approximation is inaccurate at 100 MeV but not bad at 200 MeV. Comparison with the experimetal *n-p* scattering at 90 MeV shows that the theoretical cross-section for symmetrical forces is too large by a factor of about 1·6. A.

539.152.2 2529

Relaxation effects in nuclear magnetic resonance absorption. BLOEMBERGEN, N., PURCELL, E. M., AND POUND, R. V. *Phys. Rev.*, **73**, 679–712 (*April* 1, 1948).—The absorption was observed by means of a radio-frequency bridge, the magnetic field at the sample being modulated at a low frequency. The method by which the spin-lattice relaxation time, T_1, is derived from saturation experiments is given, and relaxation times observed range from 10^{-4} to 10^2 sec. In liquids, T_1 decreases with increasing viscosity, in some cases reaching a minimum value after which it increases with further increase in viscosity. The line width increases monotonically from an extremely small value towards a value determined by the spin-spin interaction in the rigid lattice. The effect of paramagnetic ions in solution upon the proton relaxation time and line width was investigated, and the time and width in ice were measured at various temperatures. A theory of the results is given. Formulae useful in estimating the detectability of magnetic resonance absorption in various cases are derived. A.

539.152.2 2530

Shapes of nuclear induction signals. JACOBSOHN, B. A., AND WANGSNESS, R. K. *Phys. Rev.*, **73**, 942–6 (*May* 1, 1948).—The various shapes of the signals are discussed for small values of the r.f. field. In the case of a linear variation with time of the strong magnetic field, numerical results are given for various values of the sweep rate and the total relaxation time. A.

539.152.2 : 535.338.332 2531

The hyperfine structure of hydrogen and deuterium. NAFE, J. E., AND NELSON, E. B. *Phys. Rev.*, **73**, 718–28 (*April* 1, 1948).—A continuation of previous work [Abstr. 2614 (1947)]. The h.f.s. separation of the ground state of H and D was measured by observing frequencies of the r.f. field required to induce transitions among certain of the magnetic levels of the h.f.s. multiplets in magnetic fields of the order of 1 gauss. The resonance minima were of the theoretical width for transitions which are field-independent in the first order. For D, $\nu_D = 327{\cdot}384 \pm 0{\cdot}003$ Mc/s, which agrees with the previously reported value. For H, $\nu_H = 1\,420{\cdot}410 \pm 0{\cdot}006$ Mc/s which is less than the value previously reported by 0·06%. The ratio of the measured h.f.s. separations, ν_H/ν_D, is $4{\cdot}33867 \pm 0{\cdot}00004$. The h.f.s. separations, ν_H and ν_D, were calculated from known values of the magnetic moment of the proton, μ_p, and the magnetic moment of the deuteron, μ_d. The measured ν_H and ν_D are larger than the calculated values by 0·24% and 0·26%, respectively. The ratio ν_H/ν_D was calculated from the known ratio μ_p/μ_d. This ratio is independent of α^2 and R_∞. The calculated ratio is found to be higher

by 0·017%. This discrepancy is 18 times the probable error of the measurements. A.

539.153 2532

Self-consistent field, with exchange, for nitrogen and sodium. HARTREE, D. R., AND HARTREE, W. *Proc. Roy. Soc. A*, **193**, 299–304 (*July* 2, 1948).—A continuation of previous work [Abstr. 835 (1942), 717 (1941), 3894 (1939)]. Wave functions for the normal configurations of neutral N and N^- were calculated. To the accuracy of the approximation represented by Fock's equations, the N^- ion would be unstable and liable to auto-ionization, but it is estimated that a better approximation of the treatment of a many-electron atom would give a small positive ionization potential for N^-. Revised wave functions for Na^+ and the normal state of neutral Na have also been calculated. Tables of results are given. A.

539.155.2 2533

Recent advances in science. Physics. VICK, F. A. *Sci. Progr.*, **36**, 78–85 (*Jan.*, 1948).—Recent work with stable isotopes and mass spectrographs (21 references.).

539.155.2 2534

Electromagnetic separation of bromine and chlorine isotopes. CHELIUS, L. G., AND KEIM, C. P. *Phys. Rev.*, **73**, 813 (*April* 1, 1948).—$NaBr^+$ and $CuCl^+$ ion beams were used in a calutron. 91·41% Br^{81} and 8·59% Br^{79} were collected at mass 104; 90·54% Br^{79} and 9·46% Br^{81} at mass 102. $NaBr^+$ represented 30% of the Br ions in the total beam. T. G. P.

539.155.2 + 535.214 + 537.3 *see Abstr.* 2467

539.155.2 : 536.48 2535

Distribution of He^3 between liquid and vapor He^4. FAIRBANK, H. A., LANE, C. T., ALDRICH, L. T., AND NIER, A. O. *Phys. Rev.*, **73**, 729–32 (*April* 1, 1948).—The relative abundances of He^3 in the liquid and vapour phases of atmospheric He were studied as a function of temperature above and below the λ-point. The relative abundance of He^3/He^4 in the vapour, C_v, was determined by means of the mass spectrometer and the corresponding quantity for the liquid, C_L, computed from C_v and the mass balance and composition balance equations. From 5·2°K to the λ-point the ratio C_v/C_L increases as the temperature decreases, whereas below the λ-point this ratio sharply decreases to zero, showing that the vapour in equilibrium with superfluid He contains no measurable amount of He^3. A simple method for concentrating He^3 is suggested. A.

539.155.2 : 536.48 *see Abstr.* 2452

539.155.2 : 539.17 2536

Nuclear properties of 93^{237}. WAHL, A. C., AND SEABORG, G. T. *Phys. Rev.*, **73**, 940–1 (*May* 1, 1948).—The isotope Np^{237}, produced as the decay product of the previously known 6·8-day U^{237}, has been isolated with carrier material and some of its nuclear properties measured. The U^{237} was formed by means of the reaction $U^{238}(n, 2n)U^{237}$. Np^{237} decays with the emission of α-particles with a $\frac{1}{2}$-life of $\sim 3\times10^6$ years. It has been shown that the upper limit for the cross-section for the fission of Np^{237} with slow neutrons $<1\%$ of that of U^{235}. [Written 1942.]. A.

RADIOACTIVITY . NUCLEAR DISINTEGRATION NUCLEAR PARTICLES 539.16/.18

539.16 2537

Radioactivity and grain size of soil. HOOGTEIJLING, P. J., AND SIZOO, G. J. *Physica, 's Grav.*, **14**, 65–72 (*April*, 1948).—See Abstr. 1035–6 (1948). By measurements on separated grain size fractions 0–2 μ, 2–16 μ, 16–2 000 μ of several sedimentary soils, evidence was found for a preference of the radioactive elements for the grain sizes 2–16 μ. From the variation of the activity with the amount of the material, spread each time on the same surface, and from the comparison of the Ra content with the total activity, it is concluded that the composition of the radiation depends on the fineness of the material. The ratios of the concentrations of the various radioactive elements vary with the grain size. This variation is not only related to the mineral composition of the original material, but also influenced by the combined processes of solution and adsorption during the process of sedimentation. A.

539.16 2538

Measurements on the radon content of groundwater. HOOGTEIJLING, P. J., SIZOO, G. J., AND YNTEMA, J. L. *Physica, 's Grav.*, **14**, 73–80 (*April*, 1948) *In English.*—From 8 experimental borings in various parts of Holland 37 water samples were taken from strainers placed at depths varying from 5 to 200 m. The radon content and the chlorine content of these samples and the radioactivity of ground samples from the neighbourhood of the strainers were determined. The radon content shows in general a marked decrease with the depth. No correlation of the radon content with the chlorine content or with the radioactivity of the ground could be detected. The presence of a layer of clay or loam tends to increase the radon content of the water beneath it. The mean radon content of the groundwater amounts to about 5% of the equilibrium value corresponding to the mean radium content of the bottom. The various factors influencing the radon content of the groundwater are discussed. A.

539.16.08 2539

The recovery of the Wilson cloud chamber working with constant final pressure. ENDT, P. M. *Physica, 's Grav.*, **14**, 29–34 (*Jan.*, 1948) *In English.*—The various effects influencing the recovery of the chamber are mentioned. The temperature-changes after an expansion and after a compression are calculated. Also the case of a regular succession of expansions and compressions is treated. A simple method is given for finding the sensitive time and the recovery time. A.

539.16.08 2540

Some basic features of cloud chamber operation. WILSON, J. G. *Sci. Progr.*, **36**, 226–38 (*April*, 1948).—A review (14 references) under the following headings: The condensation process (charged, uncharged and re-evaporation nuclei). Supersaturation in adiabatic expansion. Measurements and identification (direction, angles and curvature; ionization; association in time of particles). The controlled chamber (speed of expansion; dead time).

539.16.08 2541

Efficiency of counting systems. BLACKMAN, M., AND MICHIELS, J. L. *Proc. Phys. Soc., Lond.*, **60**, 549–61 (*June*, 1948).—A review of the derivation of formulae for the efficiency. The system consists of a counter and amplifier, a scaling circuit and a recorder. In the case of recorders of constant resolving time, a complete formula has been derived. A number of existing formulae are shown to be valid only for a particular type of variable recorder. A discussion is given of the use of the formulae in practical counting experiments. A.

539.16.08 : 535.89 *see Abstr.* 2440

539.16.08 : 537.542 *see Abstr.* 2489

539.16.08 : 771.534.3 *see Abstr.* 2638

539.163 2542

The use of coincidence counting methods in determining nuclear disintegration schemes. MITCHELL, A. C. G. *Rev. Mod. Phys.*, **20**, 296–304 (*Jan.*, 1948).—The merits of the magnetic spectrograph and the coincidence technique are compared. Methods of analysing a complex radiation by studying β–γ and γ–γ coincidences are described and illustrated by examples. A. P. F.

539.163 2543

Erratum: Natural radioactivity of rhenium. NALDRETT, S. N., AND LIBBY, W. F. *Phys. Rev.*, **73**, 929 (*April* 15, 1948).—[Abstr. 1898 (1948)].

539.163 : 542.9 2544

Recent advances in science. General and physical chemistry. SMITH, J. W. *Sci. Progr.*, **36**, 101–12 (*Jan.*, 1948).—Subject: Tritium (radioactive hydrogen). Reviews the history of the discovery and determination of properties of H^3, and its use as a tracer in chemical investigation.

539.163.1.08 2545

The half-life of thorium C′. HILL, J. M. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 440–6 (1948).—A new coincidence method for measuring the $\frac{1}{2}$-life is described. This overcomes difficulties such as (1) random delays in the counters, (2) coincidences due to other disintegrations, (3) possibility of difference in delays in recording α- and β-particles. It is possible to determine the order in which particles are emitted. The $\frac{1}{2}$-life was found to be $3{\cdot}0 \pm 0{\cdot}15 \times 10^{-7}$ sec, the order of accuracy here being considerably better than that of any previous determinations. L. S. G.

539.163.1.08 2546

A new method of determining short half-value periods. ROWLANDS, S. *J. Sci. Instrum. Phys. Ind.*, **25**, 218–20 (*June*, 1948).—A simple method for use in the range 10^{-6} to 10^{-1} sec is described. The time intervals between radiations emitted at the beginning and end of the life of a radioactive nucleus are determined with a high-speed single-sweep oscilloscope. An application of the method to the measurement of the $\frac{1}{2}$-life period of RaC′ is described. It is also possible to use the method to determine the intensity of weak radioactive sources and the efficiencies of G.M. counters. A.

539.163.2 : 537.533.72 *see Abstr.* 2487

539.163.2 : 539.165.2 2547

The β-ray spectrum of ThC″D. MARTIN, D. G. E., RICHARDSON, H. O. W., AND HSU, Y.-K. *Proc. Phys. Soc., Lond.*, **60**, 466–81 (*May*, 1948).—The energies of the β-rays were measured using a magnetic spectrograph with semicircular focusing. Corrections were made for contamination of the source by ThC and ThB deposited by the processes of β-recoil and aggregate recoil. The absolute intensities of the stronger lines were measured and the shape of the continuous spectrum was compared with theory using three recently proposed energy level schemes for the product nucleus Pb^{208}. These level schemes fail to explain the observed shape, partly because they omit the P γ-ray (859 keV) which can now be assigned to ThC″D. Evidence for the β-excitation of energy levels at about 4·5 MeV is discussed. A.

539.163.2 : 539.166 2548

A further study of the γ-radiation from polonium. ZAJAC, B., BRODA, E., AND FEATHER, N. *Proc. Phys. Soc., Lond.*, **60**, 501–8 (*June*, 1948).—Absorption experiments using Pb, Au and W have shown that, in addition to the known γ-radiation of 0·77 MeV energy, Po emits other radiations of which the most intense has a quantum energy of 84 ± 4 keV. The intensity of this radiation is of the same order of magnitude as that of the hard radiation (roughly one quantum per 10^5 disintegrations). Experiments by the recoil method indicate that the emission of the polonium γ-radiation is not delayed by more than 10^{-1} sec. The results of Chang [Abstr. 168 (1946)] concerning the fine-structure of the α-particles of polonium remain uncorrelated with all other experimental evidence. Whilst present information regarding γ-ray energies and intensities may be reasonably explained, satisfactory explanation of the α-particle fine structure "data" appears as remote as ever. A.

539.163.2 : 539.17 *see Abstr.* 2568

539.164.8 : 537.582 254

An extension of Kapitza's theory of δ-radiation. SILLITTO, R. M. *Proc. Phys. Soc., Lond.*, **60**, 453– (*May*, 1948).—The theory is modified by the introduction of a parameter b specifying the radius of the initial temperature distribution. It is shown that a value for b inferred from the columnar ionization theory of Jaffe leads to estimates of the number of δ-electrons, most probable energy of the δ-electrons, and the duration of the emission process, which are in satisfactory agreement with experimental results for Pt. This agreement holds only for quite a small range of values of b. A.

539.165 255

The correction for self-weakening in β-ray measurements. BRODA, E., GRUMMITT, W. E., GUÉRON, J., KOWARSKI, L., AND WILKINSON, G. *Proc. Phys. Soc. Lond.*, **60**, 460–6 (*May*, 1948).—Experimental details are given for the determination of the self-weakening. The correction factor in the case of 12 radio-elements is found over a considerable region to depend logarithmically on the mass-thickness of the sample. The self-weakening $\frac{1}{2}$-thicknesses $\eta_{\frac{1}{2}}$ is as a rule $2{\cdot}2 \times >$ the external weakening $\frac{1}{2}$-thickness $\varepsilon_{\frac{1}{2}}$. The logarithmic dependence of the self-weakening correction factor on mass-thickness and the value of the ratio $\eta_{\frac{1}{2}}/\varepsilon_{\frac{1}{2}}$ are derived in a simplified theoretical treatment. A.

539.165.08 : 537.533.72 255

A high resolution nuclear spectrometer. LANGER, L. M., AND COOK, C. S. *Rev. Sci. Instrum.*, **19**, 257–6 (*April*, 1948).—A magnetic spectrometer for the measurement of β- and γ-ray energies has been constructed. By using an inhomogeneous field varying radially in the proper manner, it is possible to bring electrons which leave the source with an extremely wide spread in angle to an essentially perfect focus in 180°. It has thus been possible to use a large mean radius of curvature of 40 cm in order to obtain high resolution combined with a reasonable transmission of ~0·1% of the total solid angle. Under operating conditions, with a 0·4-cm wide source, the full width at half-max. for an internal conversion line is 0·5%. Scattering and background effects are negligible. A.

539.165.2 255

A study of RaE β-spectrum from absorption measurements. DAS GUPTA, N. N., AND CHAUDHURY, A. K. *Indian J. Phys.*, **22**, 27–38 (*Jan.*, 1948).—A new method for investigating the shape of the β-ray spectrum is described, and applied to the spectrum of RaE. The spectrum as deduced from absorption measurements agrees with the K.U. form but deviates from the original Fermi distribution. This shows that the correction factor that must be applied to the original Fermi expression in order to take into account the fact that RaE is a forbidden type of β-disintegration, is proportional to $(W_0-W)^2$. A.

539.165.2 255

The conservation of momentum in the beta-decay of Y^{90}. SHERWIN, C. W. *Phys. Rev.*, **73**, 1173–7 (*May* 15

1948).—Monolayer sources of yttrium were formed by evaporation in a vacuum of 10^{-7} mm of Hg. The momentum of individual recoil ions was measured by timing their flight in a field free space. The positively charged Zr (90) recoils appear to lose about 6 eV energy as they escape from the surface. If a 6 eV correction is made to the observed recoil spectra, there is good agreement regarding shape and absolute amplitude with those recoil spectra calculated on the assumption of a neutrino-electron angular correlation function of $(1-\beta\cos\theta)^2$. For this function the most probable angle between the neutrino and the electron is $\sim 135°$. These results are in agreement, within experimental error, with earlier data obtained with P^{32}. The exact limits of error due to chemical effects at the surface cannot yet be assigned, so it is not possible to make a definite selection of the form of the neutrino-electron angular correlation function. A.

539.165.2 : 539.163.2 *see Abstr.* 2547

539.165.2 : 539.172 2554

The reaction $He^3(n,p)H^3$ and the neutrino mass. Hughes, D. J., and Eggler, C. *Phys. Rev.*, **73**, 809–10 (*April* 1, 1948).—Careful studies, using a cloud chamber, of the proton energies in the slow neutron reactions $He^3(n,p)H^3$ and $N^{14}(n,p)C^{14}$ are described. Taken together with the $(n$-$p)$ mass difference and with the β-ray end-points for H^3 and C^{14} respectively, the results yield two values of the neutrino mass. They differ by < 5 keV and are within 25 keV of zero. A. P. F.

539.165.8 2555

On the recoil of the nucleus in beta-decay of Kr^{88}. Jacobsen, J. C., and Kofoed-Hansen, O. *Phys. Rev.*, **73**, 675–9 (*April* 1, 1948).—The maximum energy and the average energy of the recoil atoms from Kr^{88}, which emits β- and probable also γ-rays, have been determined to be $51{\cdot}5 \pm 2$ and 29 ± 1 eV, respectively. The maximum recoil energy agrees closely with the maximum energy 2·4 MeV for the γ-particles. A.

539.166 2556

The penetration of gamma-radiation through thick layers. I. Plane geometry, Klein–Nishina scattering. Hirschfelder, J. O., Magee, J. L., and Hull, M. H. *Phys. Rev.*, **73**, 852–62 (*April* 15, 1948).—A rough method is developed for estimating the intensity of γ-rays which have passed through thick targets. Only Klein–Nishina scattering is considered. The treatment is exact for those γ-rays which are unscattered or scattered once. The accuracy of the results for rays which are multiply scattered depends upon the fact that most of the scattering takes place in the forward direction with only small angles of deviation. Numerical calculations are made for energies of 2, 6 and $10m_0c^2$ and all thicknesses of target. The contributions to the intensity are given for the γ-rays which have been scattered a various number of times. Extensive tables are given which are generally useful for any problems in which only Klein–Nishina scattering is assumed. A.

539.166 2557

The penetration of gamma-radiation through thick layers. II. Plane geometry, iron, and lead. Hirschfelder, J. O., and Adams, E. N. *Phys. Rev.*, **73**, 863–8 (*April* 15, 1948).—The method of Part I [Abstr. 2556 (1948)] is extended to include the photoelectric effect and pair formation. Numerical calculations are made for the penetration of a monochromatic beam of γ-rays through targets of either Fe or Pb. The thicknesses required to reduce the energy flux of factors of 2, 10, 100, 1 000 and 10^6 are tabulated for γ-rays of 1, 3 and 5 MeV passing through air, H_2O, concrete, Fe or Pb; and the corresponding absorption coefficients are given. The distinction between roentgen per unit time and energy flux is considered and numerical tables are given for the decrease in dosage with increasing target thickness. Rough experimental agreement is obtained with the rough experimental data now available. But careful measurements of the absorption of monochromatic gamma-rays passing through very thick targets are needed. A.

539.166 : 539.163.2 *see Abstr.* 2548

539.166.2 : 539.174 2558

Gamma rays produced in the fission of U^{235}. Kinsey, B. B., Hanna, R. C., and Van Patter, D. *Canad. J. Res., A*, **26**, 79–98 (*March*, 1948).—Measurements made on the coincidence counting rate between the fissions produced in an ionization chamber and the discharges of a Geiger counter are described. By determining the absolute efficiency of the counter, the total energy emitted in the form of γ-radiation was estimated to be about $4{\cdot}6 \pm 1{\cdot}0$ MeV. Measurements were made on the range of the electrons projected from an Al radiator placed between the ionization chamber and two thin-walled counters. From this experiment, the average energy of the radiation appears to be about 2·5 MeV. The result is confirmed by absorption measurements in Pb. The absorption curve indicates a fairly homogeneous radiation and gives some evidence for the existence of a softer component with an energy of about 500 keV. A.

539.167.3 2559

Radiations from molybdenum (99) and technetium (99). Mandeville, C. E., and Scherb, M. V. *Phys. Rev.*, **73**, 848–52 (*April* 15, 1948).—The 67-hour activity was induced in Mo_2O_3 irradiated by slow neutrons in the Clinton pile. Mo^{99} emits two β-ray spectra, one of low energy, having an end point at 0·057 g/cm² in Al, the other having a maximum energy of 1·03 MeV. The β-rays of the low energy group are coupled with γ-radiation, whereas those of the spectrum ending at 1·03 MeV are not. The γ-rays of Mo^{99} have a maximum energy of 0·71 MeV as measured by coincidence absorption, and a small γ-γ coincidence rate, $0{\cdot}085\times10^{-3}$ coincidence per γ-ray, was detected in Mo^{99}. The electrons of the highly converted γ-ray of the 6-hour metastable state of Tc^{99}, separated from Mo^{99}, are non-coincident with γ-radiation. No γ-γ coincidences were observed in the technetium fraction. The conversion electrons have a range of 0·022 g/cm² in Al. A.

539.167.3 2560

A study of the breakup of Li^8. Bonner, T. W., Evans, J. E., Malich, C. W., and Risser, J. R. *Phys. Rev.*, **73**, 885–90 (*April* 15, 1948).—An experimental technique in which radioactive Li^8 atoms are introduced into the gas of a cloud chamber was used to determine the energy distribution of the α-particles from the Li^8 breakup. The maximum of the distribution occurs at 3·3 MeV and the width of half-intensity is $1{\cdot}2 \pm 0{\cdot}2$ MeV. The theoretical distribution gives good agreement with experimental data. No evidence was found for a short-range group of alpha-particles which would correspond to the disintegration energy of the ground state of Be^8. A.

539.167.3 2561

Radioactive cerium and praseodymium. Pool, M. L., and Krisberg, N. L. *Phys. Rev.*, **73**, 1035–41 (*May* 1, 1948).—A 140 ± 1-day ½-life is assigned Ce^{139}. It decays by K-electron capture to La^{139}. Two γ-rays of 0·184 and 0·8 MeV are associated with Ce^{139}. The 0·184-MeV γ-ray is partially internally converted, giving electrons of approximately 0·145 and 0·178 MeV. A $30{\cdot}6 \pm 0{\cdot}7$-day ½-life is assigned to Ce^{141} which is found to decay by the emission of a 0·66-MeV β^--particle and a γ-ray of

approximately 0·2 MeV to stable Pr^{141}. A 1·4 ± 0·1-day ½-life is assigned to Ce^{143} which decays by the emission of a 1·3-MeV β^--particle and a 0·6-MeV γ-ray to Pr^{143}. A 13·5 ± 0·1 ½-life is assigned Pr^{143} which decays to stable Nd^{143} by emission of a 0·83-MeV β^--particle. The saturation intensity ratio of the $Ce^{142}(d,n)Pr^{143}$ reaction to the $Ce^{142}(d,2n)Pr^{142}$ reaction is found to be 2·9. A.

539.167.3 2562

The disintegration of antimony 124. Kern, B. D., Zaffarano, D. J., and Mitchell, A. C. G. *Phys. Rev.*, **73**, 1142–8 (*May* 15, 1948).—The radiations from Sb bombarded by slow neutrons were investigated with the help of a magnetic lens spectrometer. Compton electrons, ejected from a Cu radiator, and photoelectrons ejected from a thin Pb radiator, were measured. γ-rays of these energies were found: 2·062, 1·708, 0·714, 0·650 and 0·603 MeV. The β-ray spectrum was measured. It is complex. An analysis according to the Fermi theory gives the possibility of resolving the spectrum into five groups with the following end-point energies and relative abundances: 2·37 MeV, 21%; 1·62 MeV, 8%; 1·00 MeV, 9%; 0·65 MeV, 44%; 0·48 MeV, 18%. An internal conversion line was detected corresponding to a γ-ray of 0·603 MeV. A γ-ray attributed to $Sb^{122}(2{\cdot}8d)$ was found to have an energy of 0·568 MeV. A.

539.167.3 2563

Energies of the beta- and gamma-rays from antimony. Cook, C. S., and Langer, L. M. *Phys. Rev.*, **73**, 1149–52 (*May* 15, 1948).—The radiations from Sb bombarded by slow neutrons were investigated. The β-spectrum of Sb^{124} (60 d) was measured with a relatively thin source and with a thin window counter. The spectrum is complex. By means of the Fermi theory, it is possible to resolve the distribution into at least five groups having the following end points and intensities: 2·37 MeV, 21%; 1·50 MeV, 7%; 0·98 MeV, 7%; 0·68 MeV, 26%; 0·50 MeV, 39%. An internal conversion line was detected corresponding to a γ-ray of 0·121 MeV. Measurements on the Compton and photoelectrons ejected from a thin Pb radiator yield additional γ-ray energies of 0·608, 0·654, 0·732, 1·708 and 2·04 MeV. Measurements made while the short-period activity was still present indicate that a γ-ray of 0·568 MeV is associated with the 2·8-day activity of Sb^{122}. A.

539.167.3 2564

Coincidence experiments in antimony 124. Jurney, E. T., and Mitchell, A. C. G. *Phys. Rev.*, **73**, 1153–6 (*May* 15, 1948).—The radiations from Sb^{124} (60 d) were measured with the help of coincidence counting methods. The β-ray absorption curve was measured and analysed. Two groups of electrons were found with end points at 2·24 and 0·51 MeV. γ-γ and β-γ coincidences were measured. A plot of the number of β-γ coincidences per recorded β-particle indicates that the spectrum is complex. Two low-energy groups were found with end points at 0·75 and 0·47 MeV. A.

539.17 2565

Excitation function for proton-neutron reaction in lithium ($Li^7(p,n)$). Hill, J. E., and Shoupp, W. E. *Phys. Rev.*, **73**, 931–3 (*May* 1, 1948).—The function was studied in the region from the threshold, 1·85 MeV, to 3·20 MeV. Neutron groups were found to be emitted at proton energies of 1·92, 2·28 and 3·06 MeV, suggesting the existence of energy levels in Be^8 at 19·8, 19·1, 18·8 MeV in addition to the other well-known states. A.

539.17 2566

X-ray yield curves for γ–n reactions. Baldwin, G. C., and Klaiber, G. S. *Phys. Rev.*, **73**, 1156–63 (*May* 1 1948).—Yield curves for the reactions $C^{12}(\gamma,n)C^{11}$ an $Cu^{63}(\gamma,n)Cu^{62}$ were taken with X-rays up to 100 MeV The induced radioactivity at each energy was plotted pe unit X-ray intensity as measured by a *r*-meter thimbl jacketed by ⅛ in of Pb. Both yield curves are similar t the photo-fission yield curves, the X-ray yield increasin to a maximum and then slowly decreasing as the X-ra energy is increased. With simple assumptions regardin the generation of ionizing secondaries in the Pb walls c the monitor and assumption of a constant intensit X-ray spectrum, these curves can be analysed. Th relative cross-section is found to have a maximum a approximately 22 MeV for Cu^{62} and 30 MeV for C^{11} decreasing to negligible values at high quantum energies This decrease in cross-section can be attributed to com petition from multiple disintegrations. These reaction provide detectors sensitive only to part of the X-ra spectrum. Absorption curves were taken in Pb usin U photo-fission and in Cu and Pb using the $Cu^{63}(\gamma,n)Cu^{6}$ reaction as detectors. The resulting absorption coefficient compare favourably with theoretical values. A

539.17 : 523.841.11 : 523.11 = 3 *see Abstr.* 2307

539.17 : 537.591 256

Emission of Li^8 in the explosive disintegration of nuclei Franzinetti, C., and Payne, R. M. *Nature, Lond.*, **161** 735–6 (*May* 8, 1948).—A further analysis of "hamme tracks" [Abstr. 673 (1947)]. 28 examples have now bee observed at Bristol. 13 of these show that durin disintegration, Li^8 is accompanied by a strongly ionizin particle, probably an α-particle, and a proton. It i estimated that the phenomenon observed is the disintegra tion of C^{12} by a fast proton. L. S. G.

539.17 : 539.155.2 *see Abstr.* 2536

539.17 : 539.163.2 256

Gamma-rays from alpha-particle reactions. Alburger D. E. *Phys. Rev.*, **73**, 1014–19 (*May* 1, 1948).—γ-ray from Na, Mg, Al, Si, P and S targets under cyclotron bombardment by 7-MeV α-particles were observed Energies were obtained by measuring the maximum range of Compton-recoil electrons in Al, using two β-ray counters in coincidence. The γ-ray energies found were Na, 1·85 ± 0·15 MeV and 2·80 ± 0·25 MeV, with an intensity ratio of 6 to 1; Mg, 1·8 ± 0·2 MeV and 4·3 ± 0·3 MeV, with an intensity ratio of 3 to 1; Al 3·5 ± 0·3 MeV; Si, 2·3 ± 0·3 MeV; P, 2·55 ± 0·25 MeV and 4·1 ± 0·4 MeV, with an intensity ratio of 8 to 1; S, 2·4 ± 0·3 MeV. In cases where correlation can be made with energy levels given by the corresponding α–p reactions the transition from the second excited state to ground in the product nucleus seems to be favoured. A

539.17 : 539.18 256

The absorption of slow mesons by an atomic nucleus Ferretti, B. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 75–7 (1948).—The treatment of the absorption of mesons by deuterons as a one-body problem is incorrect, and a more correct procedure leads to selection rules changing the order of magnitude of the results. G. J. K.

539.17 : 539.185 2570

A photographic study of the neutron spectra from Al(αn) and Si(dn). Peck, R. A., Jr. *Phys. Rev.*, **73**, 947–55 (*May* 1, 1948).—The new Eastman NTB nuclear particle emulsion was used. Details of the experimental method are discussed, with reference to some features of the histogram representation employed. The following mass differences were obtained: P^{30}–Al^{27} = 2·998 06 ± 0·24×10⁻³ mass units, P^{29}–Si^{28} = 1·006 64 ± 0·14×

10^{-3}, P^{30}–$Si^{29} = 1{\cdot}002\,15 \pm 0{\cdot}21 \times 10^{-3}$, P^{31}–$Si^{30} = 1{\cdot}000\,88 \pm 0{\cdot}18 \times 10^{-3}$. A level in P^{30} at $1{\cdot}02 \pm 0{\cdot}12$ MeV above ground was found and confirmed, and three levels in P^{31} were established. Group widths and intensities are listed. A.

539.172 2571

The transmutation of magnesium, aluminium and silicon by deuterons. Allan, H. R., and Wilkinson, C. A. *Proc. Roy. Soc. A*, **194**, 131–45 (*July* 28, 1948).—A study has been made of the protons emitted by Mg, Al and Si targets when bombarded by deuterons of energy between 700 and 1 000 keV. The Q values of these (d, p) reactions have been accurately determined. The Q values and assignments are: Mg^{24}, 5·03; Mg^{25} to excited Mg^{26}, 4·45; Mg^{26}, 4·05; Al^{27}, 5·46; to excited Al^{28}, 4·46, 3·98, 3·31; Si^{28}, 6·16; to excited Si^{29}, 4·87, 3·75; Si^{30}, 4·16 MeV. The yield of the proton group attributed to Mg^{25} (d, p) Mg^{26*} shows a resonance at 955 kV bombarding voltage, as does also the yield of radioactive Al^{26} formed in the reaction $Mg^{25}(d, n)Al^{26}$. This indicates a resonance level in the compound nucleus Al^{27} at an excitation energy of 17 MeV. The maximum energy of the β^+ rays from Al^{26} was measured as 2·8 MeV. The Q values listed above lead to a set of nuclear mass values, but these mass values are not always in satisfactory agreement with the published Q values for certain other reactions. A.

539.172 2572

On the behavior of cross sections near thresholds. Wigner, E. P. *Phys. Rev.*, **73**, 1002–9 (*May* 1, 1948).—[See Abstr. 2610 (1947)]. The energy-dependence of the cross-section for the formation of a product, near the threshold energy for that formation, is considered. The cross-section is the same function of energy, no matter what the reaction mechanism is, as long as the long-range interaction of the product particles is the same. The same must hold for the back reaction, i.e. the reaction between particles with very low relative velocities. In this case, the cross-section, as function of the energy, depends only on the long-range interaction of the reacting particles. The energy dependence of the cross-section is determined for three types of interactions, no interaction, Coulomb repulsion and Coulomb attraction. The rule for a $1/r^2$ interaction can be obtained from the first case. Reasons are adduced to show that two interactions, the difference of which goes to zero at least as fast as $r^{-2-\varepsilon}$ (with $\varepsilon > 0$), give the same energy dependence of the cross-section. Hence, long-range interaction in the above connection should mean an interaction which, at large distances of the particles, does not go to zero faster than r^{-2}. The effect of small perturbations in the long-range interaction is discussed. A.

539.172 : 537.133 2573

Energy distribution of protons from a target bombarded by 190-Mev deuterons. Chupp, W. W., Gardner, E., and Taylor, T. B. *Phys. Rev.*, **73**, 742–9 (*April* 1, 1948).—According to previous experimental work [Abstr. 742 (1948)] a narrow beam of high energy neutrons is produced when a beam of 190-MeV deuterons strikes a thin target. For the mechanism for the production of the neutrons see Abstr. 943 (1948). In the process the proton in the deuteron strikes the edge of a nucleus in the target and is stripped off, while the neutron misses and continues on its way. It is to be expected that an equal number of high energy protons are produced by stripping processes in which it is the neutron that hits the nucleus. These high energy protons were detected by (1) carbon activation, and (2) photographic plates. Both methods give energy distributions in agreement with the energy distribution predicted for protons produced by the stripping process. A.

539.172 : 539.165.2 *see Abstr.* 2554

539.172 : 539.185 2574

The neutrons emitted in the disintegration of nitrogen by deuterons. Gibson, W. M., and Livesey, D. L. *Proc. Phys. Soc., Lond.*, **60**, 523–32 (*June*, 1948).—The photographic plate method was used in the experiments. A single group of neutrons, corresponding to an energy release of $5{\cdot}15 \pm 0{\cdot}10$ MeV, was detected, but the existence of the low-energy neutron group reported by Stephens, Djanab and Bonner [Abstr. 141 (1938)] was not confirmed. The new results show that, if this group does exist, its intensity $\gtrsim 15\%$ of that of the principal neutron group, and that no excited levels of the O^{15} nucleus < 5 MeV above the ground state are effective in this reaction. The neutron flux from the $n + D$ reaction was compared with that of $D + D$ neutrons produced by disintegration of deuterium present in the surface layers of the target employed. The data obtained were used in determinations of the angular distributions of the $D + D$ and $n + D$ neutron fluxes, and in tests of the reliability of the photographic plate method for relative flux measurements. A.

539.172.1 2575

Resonances in the disintegration of fluorine and lithium by protons. Bonner, T. W., and Evans, J. E. *Phys. Rev.*, **73**, 666–74 (*April* 1, 1948).—The resonances in the emission of γ-radiation from F bombarded by protons have been studied from 300 to 850 keV. Resonances were observed at 334, 479, 590, 660 and 820 keV with width at $\frac{1}{2}$-intensity, respectively, of 3·2, 2·6, 37, 7·5 and 8·3 keV. The absolute cross-sections at resonance were found to vary from $0{\cdot}4 \times 10^{-26}$ for the resonance at 590 to $5{\cdot}9 \times 10^{-26}$ cm² for that at 334 keV. These results and previous results for the resonances at higher energies were compared to the single level dispersion formula, and the values of partial widths due to proton re-emission were found to vary from 10 V at the 1 076 keV resonance to 5·7 keV for that at 1 363 keV. The resonance in the emission of 17 MeV γ-radiation from Li bombarded by protons at 440 keV was found to have an experimental width of 14 keV. The cross-section for the reaction at the peak of the resonance is $7{\cdot}2 \times 10^{-27}$ cm². The resonance curve is not symmetrical and cannot be explained by the single level dispersion formula. A.

539.172.13 2576

Low energy yield of $D(D,p)H^3$ and the angular distribution of the emitted protons. Bretscher, E., French, A. P., and Seidl, F. G. P. *Phys. Rev.*, **73**, 815–21 (*April* 15, 1948).—The thick target yield $N(E)$ of the reaction, $D^2 + D^2 \rightarrow H^3 + H^1 + 4{\cdot}0$ MeV, was studied using a heavy ice target, and the angular distribution of the protons was observed. Experiments were carried out from 15 to 105 keV incident deuteron energy. There is evidence that even for very small bombarding energies the angular distribution of protons in the c.g. system does not become isotropic. Evaluation of the cross-sections $\sigma(E)$ from $N(E)$ involves an estimate of the energy loss of deuterons in heavy ice. The variation of cross-section $\sigma(E)$ with energy E can only approximately be represented by a Gamow function, i.e. $\sigma(E) \propto (1/E) \exp[-c/(E)^{\frac{1}{2}}]$. A.

539.172.13 2577

Theoretical considerations concerning the $D + D$ reactions. Konopinski, E. J., and Teller, E. *Phys. Rev.*, **73**, 822–30 (*April* 15, 1948).—Some possibilities are explored for the theoretical explanation of the angular distribution of $D + D$ reaction products. The variation

with energy is ascribed to differences in the centrifugal barriers encountered by the bombarding particles responsible for the isotropic and non-isotropic components. The detailed data on the proton distributions at low energies appear to be explained in terms of an asymmetric part produced by *P*-waves superposed on isotropic emissions caused by *S*-waves. However, ordinary extrapolation of this to higher energies gives much less symmetric distributions than experimentally found at such energies for the emission of neutrons. The experiments appear to show that spin-orbit coupling plays a large part in the reactions. An isotropic component produced by incoming *P*-waves grows in importance with energy and accounts for the increasingly parallel growth of the isotropic and asymmetric emissions. A.

539.172.3 2578

Disintegration of Be^8. HEMMENDINGER, A. *Phys. Rev.*, **73,** 806 (*April* 1, 1948).—Photodisintegrations were produced by MsTh γ-rays in a Be^9 layer on the inner wall of a He-filled proportional counter. The α-particle pulses then resulting from breakup of Be^8 were measured, and their sizes compared with those from He recoils produced in the counter by neutrons of known energy. It is concluded that the disintegration energy of Be^8 is 116 ± 10 keV. A. P. F.

539.172.4 2579

The disintegration of boron by slow neutrons. II. GILBERT, C. W. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 447–52 (1948).—Experiments previously described [Abstr. 2390 (1938)] were repeated in 1939, and the results are now published. The reaction studied is $B^{10}(n,\alpha)Li^7$. A cloud chamber containing B vapour was used. Total ranges of α-particles and Li particles were measured. The main group, consisting of 91·4% of the disintegrations, was measured before. But there is also a long-range group (8·6%) corresponding to the Li being left in the ground state. The energies calculated by using the known masses do not agree with those deduced from the measured ranges and the range-energy relation for α-particles, and it is suggested that the latter is at fault. The angular distribution of the disintegration particles was found to be spherically symmetrical. L. S. G.

539.172.4 2580

Fission of elements from Pt to Bi by high energy neutrons. KELLY, E. L., AND WIEGAND, C. *Phys. Rev.*, **73,** 1135–9 (*May* 15, 1948).—The neutron beam of the 184-in cyclotron was used to produce fission in elements from Pt to Bi. The atomic fission yields relative to Th for 84 MeV neutrons are Bi 0·019, Pb 0·0055, Tl 0·0032, Hg 0·0023, Au 0·0020 and Pt 0·0009. Yield curves for reduced neutron energies were determined. Significant differences in the fission yields of the abundant Pb isotopes were found. With 84 MeV neutrons the maximum fission fragment ionization relative to Th was 0·8 for Bi and ranged down to about 0·7 for Au. A.

539.172.4 : 539.185 *see Abstr.* 2591

539.172.4 : 615.849 *see Abstr.* 2635

539.174 2581

The excitation of nuclei by electrons. SNEDDON, I. N., AND TOUSCHEK, B. F. *Proc. Roy. Soc. A*, **193,** 344–56 (*July* 2, 1948).—The cross-section for the inelastic scattering of electrons by atomic nuclei is calculated assuming the process to arise from the electromagnetic interaction between electrons and protons. For fast electrons scattered by Cd the cross-section obtained is in fair agreement with recent experimental estimates. Difficulties, due to the failure of Born's approximation, arise when an attempt is made to apply the theory to th explanation of the electron excitation curves recent observed by Wiedenbeck. [Abstr. 1855 (1945)].

539.174 : 539.166.2 *see Abstr.* 2558

539.18 25

Note on stimulated decay of negative mesons. EPSTEI S. T., FINKELSTEIN, R. J., AND OPPENHEIMER, J. R. *Phy Rev.*, **73,** 1140–1 (*May* 15, 1948).—Theories in which th decay is accelerated by electrostatic fields are investigate These always give radiative decay for free mesons. Th competition of radiationless decay of negative meso increases with Z^5, and the two rates become equal for value of Z which depends somewhat on the choice coupling, but which, for one simple form, is 12. Expe mental evidence probably disproves theories of th kind.

539.18 : 530.145 25

Mesons of different masses. BARNÓTHY, J. *Natur Lond.*, **161,** 681 (*May* 1, 1948).—The author gives a sho account of his recent theory [*Papers on Terr. Magnetis (Hungary)* No. 2 (1947)] which postulates that electron and similarly protons, may exist in unstable "mes states." There is one electron meso-state and 82 prot meso-states; the properties of the first 9 of the latter a tabulated and tentative assignments of recently-discover particles are made.

539.18 : 530.145.6 = 4 *see Abstr.* 2352

539.18 : 537.591 *see Abstr.* 2493

539.18 : 539.17 *see Abstr.* 2569

539.185 25

Slow neutron experiments in Groningen. COSTER, D GROENDIJK, H., AND DE VRIES, H. *Physica, 's Grav.*, **1** 1–7 (*Jan.*, 1948) *In English.*—Values are derived for t energies and the effective widths of the resonance levels the following nuclei: Au^{198}, Ag^{108}, Ag^{110}, Cu^{64}, Cu^{66}, Al^2 Zn^{69} and Cd^{117}. They have been derived from previo measurements applying a correction for impurity of bor samples [Abstr. 1646 (1947)]. The thus corrected valu for the resonance energies of Au and Ag are in agre ment with those obtained with the aid of the time-c flight method. It is shown that of the three levels Ag (5·1, 16 and 45 eV) the first belongs to Ag^{110} (22 se and the second to Ag^{108} (2·3 min). Overlapping leve of Ag^{110}, Cu^{66} and Cd^{117} were found at about 100 eV.

539.185 25

Angular distribution of neutrons inside a scattering a absorbing medium. WALLACE, P. R. *Canad. J. Res.*, **26,** 99–114 (*March*, 1948).—A method is developed f determining the moments of the angular distribution mono-energetic neutrons diffusing inside a homogeneo medium. It is applicable to the region in which surfa effects may be neglected. A general derivation is given f the current-density relation, involving no assumptio about the relative cross-sections for scattering and captur The second moment is expressed in terms of derivativ of the density, and the analogous procedure for high moments is indicated. Moments of the angular distrib tion relative to arbitrary directions in space are define general formulae and applications to special cases a given for the second moment.

539.185 25

The diffraction of neutrons by crystalline powde WOLLAN, E. O., AND SHULL, C. G. *Phys. Rev.*, **73,** 830– (*April* 15, 9148).—The powdered crystal technique w applied to neutron diffraction. Neutrons from t Clinton pile were monochromatized by reflection from single crystal and the diffraction patterns produced wh

these neutrons fall on specimens of crystalline powders were studied. Results have given (*a*) a check on some aspects of the diffraction theory, (*b*) the magnitude and sign of the scattering amplitudes from various nuclear species from which information is obtained on the spin dependence of the scattering, which has a bearing on the magnitude and range of nuclear forces, and (*c*) an improvement in the techniques and a better understanding of the problems involved so that results can be more readily obtained on the diffraction by other crystals, such as those containing hydrogen or deuterium. Diffraction measurements were obtained on diamond, graphite, Al, Na, NaBr, NaCl and NaF in which all intensity measurements were standardized against diamond, to which a definite cross-section was assigned on the basis of total cross-section measurements. The scattering of carbon, Al and F was found to have no measurable spin-dependence. The scattering by Na, however, showed a considerable spin-dependence as evidenced by a Bragg scattering cross-section of 1·51 as against a total scattering cross-section of $3\cdot7\times10^{-24}$ cm². Measurements have been made on a number of other crystals with the purpose of determining the phase of scattering. A table showing the scattering phase for a number of elements is given. A.

539.185 2587

Neutron diffraction studies of NaH and NaD. SHULL, C. G., WOLLAN, E. O., MORTON, G. A., AND DAVIDSON, W. L. *Phys. Rev.*, **73**, 842–7 (*April* 15, 1948).—Patterns for NaH and NaD were found; from these it is established that the crystal structure is analogous to that of NaCl with the H centres replacing Cl. It is shown that both Na and D scatter neutrons with a positive scattering amplitude whereas hydrogen scattering is characterized by a negative scattering amplitude. The coherent scattering cross-sections for H and D are determined as $2\cdot0\pm0\cdot3$ and $4\cdot1\pm1\cdot2\times10^{-24}$ cm², respectively. Using this value of the coherent scattering cross-section for H and Melkonian's value of 20×10^{-24} cm² for the total scattering cross-section by a free proton, the scattering amplitudes characteristic of the two proton spin states have been evaluated, and these are in good agreement with the latest data on the scattering of neutrons by *o*- and *p*-H. The range of nuclear forces present in the neutron-proton triplet interaction is evaluated as $1\cdot6\pm0\cdot2\times10^{-13}$ cm. A.

539.185 2588

Scattering of 100 MeV neutrons by protons. BARKER, F. C. *Nature, Lond.*, **161**, 726–7 (*May* 8, 1948).—The differential cross-section for the scattering was calculated, using an exponential-well potential. The 2 cases of exchange forces and symmetric forces were considered. L. S. G.

539.185 : 530.145 2589

Scattering of high-energy neutrons by protons. HULTHÉN, L., AND PAIS, A. *Rep. Internat. Conf.* "*Fundamental particles*" (1946) (*Phys. Soc., Lond.*) **1**, 177–80 (1948).—The scattering is calculated for the energy range 0–25 MeV using the Møller–Rosenfeld symmetric meson theory, and compared with earlier results with a neutral theory. G. J. K.

539.185 : 537.534.74 2590

Note on second Born approximation and proton-neutron and proton-proton scattering. WU, T.-Y. *Phys. Rev.*, **73**, 934–9 (*May* 1, 1948).—The scattered amplitude is taken as a series in powers of the interaction potential V, and the scattered intensity is calculated up to the fourth power of V. The calculation can be carried out analytically for a Gaussian potential, leading to a simple way of calculating the second approximation for the phases. The result is applied to the *p-n* and *p-p* scattering at 100 MeV, on the basis of the three forms of nucleon interaction suggested by Rarita and Schwinger [see Abstr. 1356 (1941)], with a Gaussian $V(r)$ and without tensor forces. The result for the symmetrical theory is: $\sigma_{p-n}=0\cdot96\times10^{-25}$ cm², $\sigma_{p-p}=0\cdot22\times10^{-25}$ cm², as compared with the first approximation values $1\cdot40\times10^{-25}$ and $0\cdot28\times10^{-25}$ cm², respectively. These give for $(\sigma_{p-n}+\sigma_{p-p})$ the value 1·18, in much closer agreement with the observed value 1·17 for σ_{p-d} than the other two forms of interaction potential. A.

539.185 : 537.534.74 : 539.152.1 *see Abstr.* 2527–8

539.185 : 539.17 *see Abstr.* 2570

539.185 : 539.172 *see Abstr.* 2574

539.185 : 539.172.4 2591

Total cross section of Fe, Ni, and Bi for fast neutrons. BARSCHALL, H. H., BOCKELMAN, C. K., AND SEAGONDOLLAR, L. W. *Phys. Rev.*, **73**, 659–65 (*April* 1, 1948).—These have been measured for neutrons of from 10 to 500 keV energy with a resolving power of ~ 20 keV, and from 200 to 1 400 keV with a resolving power of ~ 150 keV. With the higher resolving power marked fluctuations in cross-section, indicating the presence of resonances, were observed in Fe and Ni, but not in Bi. A.

539.185.7 2592

Slow neutron velocity spectrometer studies of H, D, F, Mg, S, Si, and quartz. RAINWATER, L. J., HAVENS, W. W. JR., DUNNING, J. R., AND WU, C. S. *Phys. Rev.*, **73**, 733–41 (*April* 1, 1948).—A continuation of previous work [Abstr. 1317 (1947)]. The neutron-proton cross-section was measured using a paraffin sample. The observed free proton cross-section is $20\cdot6\pm1$. The cross-section curve below 0·05 eV is well matched by a theoretical curve and approaches 4 times the free proton cross-section at very low energies. The thermal cross-section of D_2O is well matched by the curve $\sigma_{D_2O}=10+0\cdot72E^{-\frac{1}{2}}$. The free cross-section of D is $3\cdot3\pm0\cdot2$. The thermal cross-section of F in a fluorocarbon oil is well matched by the curve $\sigma_F=3\cdot3+0\cdot11E^{-\frac{1}{2}}$. The cross-section of the free F is $3\cdot3\pm0\cdot5$. The cross-sections of Mg and Si are essentially constant at $3\cdot4\pm0\cdot1$ and $2\cdot25\pm0\cdot1$ eV. No resonances are observed. Microcrystalline interference effects are noticed in the low energy region. The thermal cross-section of S is well matched by the curve $\sigma=0\cdot098E^{-\frac{1}{2}}$. No resonances are observed in S. The effective neutron cross-section of an optical quartz crystal decreases from the additive cross-section of $9\cdot2\pm0\cdot2$ at ~ 10 eV to 1·5 at 0·025 eV which is taken to be the residual incoherent cross-section. A.

539.185.7 2593

Search for a resonance absorption of neutrons in graphite. BERNSTEIN, S. *Phys. Rev.*, **73**, 956–62 (*May* 1, 1948).—Experiments were made to determine whether or not an appreciable absorption of neutrons takes place in graphite during the slowing down process. A Ra–Be photoneutron source was surrounded by a solid sphere of graphite of 11-in radius. The sphere was immersed in an essentially infinite mass of paraffin. The activities of thin indium foils due to thermal neutrons were measured as a function of distance from the source for the following two cases: (*a*) with the sphere in place, (*b*) with the sphere removed. From these distributions and the relative thermal neutron capture cross-sections of graphite and paraffin, the relative numbers of neutrons captured as

thermal neutrons in the two cases were calculated. The difference between these two numbers is a measure of the number of neutrons absorbed by the graphite sphere during the slowing down process. The results indicate that if a resonance absorption exists in graphite, then, at most, 5% of all neutrons passing through such a level would be absorbed by the 11-in radius sphere. A.

539.185.7 2594

Slow neutron velocity spectrometer studies of Cu, Ni, Bi, Fe, Sn, and calcite. HAVENS, W. W., JR., RAINWATER, L. J., WU, C. S., AND DUNNING, J. R. *Phys. Rev.*, **73**, 963–72 (*May* 1, 1948).—The thermal cross-section of Cu is well matched by the curve $\sigma = 7{\cdot}8 + 0{\cdot}54E^{-\frac{1}{2}}$. Microcrystalline interference is observed in the low energy region. The cross-section decreases slowly from 8 to 7·3 between 2 and 100 eV, then decreases more rapidly until at zero timing it is 5·3. A small dip is observed near 3 000 eV. The thermal cross-section of Ni is well matched by the curve $\sigma = 17{\cdot}0 + 0{\cdot}77E^{-\frac{1}{2}}$. Microcrystalline interference effects are observed at low energies. The Ni cross-section is approximately constant at 17·2 from 3 to 50 eV. A small dip is observed with a minimum near 100 eV. Above 100 eV the cross-section drops rapidly to 8 at zero time of flight. Bi shows no $1/v$ slope in the thermal region because of microcrystalline interference effects. The free cross-section of Bi is $9{\cdot}0 \pm 0{\cdot}2$ and is constant over the energy region investigated. The thermal cross-section of Fe is well matched by the curve $\sigma = 11{\cdot}0 + 0{\cdot}35E^{-\frac{1}{2}}$. Microcrystalline interference effects are observed in the low energy region. The cross-section of Fe remains approximately constant at 11 from 3 to 300 eV, then decreases to 4·8 at zero time of flight. The cross-section of Sn in the thermal region rises because of microcrystalline interference effects which mask any $1/v$ slope. The free cross-section is $4{\cdot}9 \pm 0{\cdot}1$. There is a slight dip in the transmission curve of tin around 6 eV which may or may not be real. Other small dips near 50 and 100 eV are probably real. The cross-section increases near zero time of flight indicating that there are probably resonances above 1 000 eV. The cross-section of a large Nicol prism decreases from the additive $CaCO_3$ cross-section of 20 at short wavelengths to about 3·5 at 0·005 eV. A.

539.185.7 2595

Comparison of cross-sections for the capture of 220 and 900 keV neutrons. ALLEN, R., BISHOP, G. R., DEMERS, P., AND HALBAN, H. *Nature, Lond.*, **161**, 727 (*May* 8, 1948).—The methods for producing the neutrons and obtaining the ratios of the cross-sections are briefly described. Nuclei studied are: Al^{28}, Mn^{56}, Cu^{64}, Cu^{66}, As^{76}, Br^{80}, Br^{82}, Rh^{104}, $Pd^{104,109}$, Pd^{111}, Ag^{108}, Ag^{110}, In^{116}, Sb^{112}, I^{128}, Ba^{130}, Te^{131}, Dy^{165}, W^{187}, Pt^{199}, Au^{198}. L. S. G.

STRUCTURE OF SOLIDS 539.2

539.21 : 576.8.097 *see Abstr.* 2633

539.215.2 : 539.37 *see Abstr.* 2605

539.215.4 : 538.114 *see Abstr.* 2500

539.217.3 2596

On the permeability of media consisting of closely packed porous particles. BRINKMAN, H. C. *Appl. Sci. Res.*, **A 1** (*No.* 2) 81–6 (1948).—A previous calculation [Abstr. 841 (1948)] of the permeability of a swarm of particles is extended to closely packed particles. An approximate model is introduced for the fluctuations of the mean density of the particles surrounding a central one a adjusted so as to represent the experimental results. Tl refined model serves as a basis for an extension of t calculation to particles which themselves are permeab such as occur in catalyst pellets.

539.23 25

Anisotropy phenomena in polystyrolene with an orient distribution of particles. DALETSKY, G. F. *C.R. Acc Sci. URSS*, **54** (*No.* 4) 311–13 (1946).—Oriented films polystyrolene, acetyl- and nitro-cellulose were obtain by pouring a solution of the polymer under investigati on the surface of Hg, from which they were taken af slow evaporation of the solvent. The electric, mechanic and optical properties of the films were studied and structural scheme was suggested on the basis of the Oriented layers up to several mm in thickness may made. A 3-dimensional orientation may be obtained stretching. Oriented films have properties similar to thc of a crystal of the rhombic system. L. S.

539.23 25

Structure of cathodic films formed on aluminium in gas (oxygen) discharge. IGNATOV, D. V. *C.R. Acc Sci. URSS*, **54** (*No.* 4) 329–32 (1946).—The films we investigated by an electron diffraction method. Th patterns showed a series of rings, which nearly ov lapped those corresponding to metallic Al, and which a interpreted as a diffraction maxima from a cubic crys lattice of constant $a = 3{\cdot}95$ Å. The films were found have the same structure as anodic films formed in electrolytic solution, so that the latter develops direc as the result of the counter diffusion of O_2 and particles. L. S.

539.23 25

Structure of primary films of oxide and bromide of silv TIAPKINA, V. V., AND DANKOV, P. D. *C.R. Acad. S URSS*, **54** (*No.* 5) 415–18 (1946).—An electron diffracti analysis of the oxide film, prepared by oxidation in a g discharge, shows that the oxide is a structure of cupr type with a cubic lattice constant, $a = 4{\cdot}69$ Å. For t bromide film, the cubic lattice constant is $a = 5{\cdot}76$ Figures of the diffraction patterns are given. That t the bromide is sharp, but the pattern for the oxide sho appreciable fog, which is associated with irregular scatt ing of electrons from irregularly located elements of t film structure. L. S.

539.24 : 548.7 26

The thermal etching of silver. CHALMERS, B., KING, R AND SHUTTLEWORTH, R. *Proc. Roy. Soc. A*, 19 465–83 (*July* 21, 1948).—The mechanism whereby gra boundaries are delineated and striations formed polished surfaces of heated metal specimens was examine Experiments on electrolytically polished Ag show th grooves form at grain boundaries at temperatures as lo as 300°c and striations at 500°c in air. Striations or appear in the presence of oxygen and may be removed heating in nitrogen. A furnace for high-temperatu photomicrography, suitable for specimen temperatures to about 950°c, is described. Previous theories a inadequate to explain the effects observed in Ag, and theory which regards the surface etching as an approa to equilibrium by the reduction of surface free energy suggested. The equilibrium condition of the bounda is a groove whose shape is determined by the relati magnitudes of the free energy per unit area of t boundary and the surface energies of the crystalline fac meeting the boundary in the surface of the specime The striations are caused by the development of the crystalline planes having the lowest free energy;

relative surface energies of different planes being modified by the presence of oxygen. It is suggested that the chief means whereby the boundary grooves are formed is that of surface migration of ions: both surface migration of ions and evaporation of silver oxide molecules may be expected to play major parts in the formation of the striations. A.

539.25 : 621.385.833 2601

Recent advances in electron microscopy in the United Kingdom. COSSLETT, V. E. *Research, Lond.*, **1**, 293–304 (*April*, 1948).—This paper largely consists of a review of applications of electron microscopy to smoke and dust analysis, metallurgy and biological work. A short description of the Metropolitan-Vickers EM3 machine is included.

539.26 : 539.374 *see Abstr.* 2607

539.26 : 539.434 *see Abstr.* 2610

ELASTICITY . STRENGTH . RHEOLOGY 539.3/.8

539.32 : 548.0 2602

Elastic constants of ammonium alum. SUNDARA RAO, R. V. G. *Curr. Sci.*, **17**, 50 (*Feb.* 1948).—These were determined by the wedge method [Abstr. 2565 (1945)] using ultrasonic frequencies up to 8 Mc/s. The constants C_{11}, C_{12}, C_{44} and the bulk modulus K calculated from them, are 2·50, 1·06, 0·80 and 1·54 in units of 10^{11} dynes/cm². The values for K and Cr alums are 2·56, 1·07, 0·86, 1·57; and 2·37, 0·93, 0·77, 1·41 respectively.

539.32 : 548.7 2603

A theoretical determination of the elastic constants of ice. PENNY, A. H. A. *Proc. Camb. Phil. Soc.*, **44** (*Pt* 3) 423–39 (1948).—A simple Barnes model is taken [Abstr. 901 (1930)]. The H-atoms are assumed to lie in the centre between two O atoms, and only nearest-neighbour interaction is considered. Regularity is also assumed, since any 4 neighbouring O atoms lie at the vertices of an almost regular tetrahedron. Under these conditions there are 2 atomic constants. Two of the experimental measurements of the constants of polycrystalline ice are used to calculate the atomic constants, and then the 5 elastic constants for a single crystal. L. S. G.

539.37 2604

Dynamic straining of amorphous or quasi-amorphous substances. SWAINGER, K. H. *Research, Lond.*, **1**, 473–4 (*July*, 1948).—A general theory on straining is evolved for amorphous or quasi-amorphous substances in which normal stresses induce normal strains. All unit lengths, areas and volumes are taken in the deformed body to give "true" stresses, strains and stress/strain parameters. Elastic, plastic and flow components of strain each produce appropriate transverse contractions. The deformed body is freed from rigid body translation and rotation by causing the orthogonal axes of the strain ellipsoid at any one arbitrary point to coincide at each instant with the corresponding orthogonal line elements in the undeformed body. The resulting "straining displacement" of each point of the continuous body is associated mathematically with the strains which are associated physically with the stresses. When the equations are considered for the propagation of normal stress one may derive as a special case a one-dimensional statement for post-yield stresses; a term to allow for viscosity is included and accounts for decay of stress. The equations apply equally well to flowing solids or fluids after introducing a coefficient of viscous extension. A.

539.37 : 539.215.2 2605

Mechanical behaviour of crystal boundaries in metals. KING, R., CAHN, R. W., AND CHALMERS, B. *Nature, Lond.*, **161**, 682 (*May* 1, 1948).—Specimens of Sn consisting of two crystals and a straight boundary were loaded to provide a shear stress on the boundary. Lateral displacement occurred a few deg. below the melting point (shear stress component 590 gm/cm², initial rate of relative movement 7×10^{-4} cm/hr; max. movement recorded 0·1 mm). See Abstr. 1656 (1947).

539.374 2606

On the stress-strain relations in the theory of plasticity. KACHANOV, L. M. *C.R. Acad. Sci. URSS*, **54** (*No.* 4) 309–10 (1946).—A thermodynamic theory, assuming deformation is isothermal, leads to differential equations for the stress/strain relations. A comparison is outlined with the theories of Prager and von Mises. L. S. G.

539.374 : 539.26 2607

Internal stresses in metals. WOOD, W. A., AND DEWSNAP, N.; GREENOUGH, G. B. *Nature, Lond.*, **161**, 682–3, (*May* 1, 1948).—The suggestions of Greenhough [Abstr. 3692 (1947)] that measured internal stresses may be explained in terms of "intergranular" stresses are disputed. A reply by Greenhough is appended.

539.4.016.2 : 548.73 2608

Stressed aluminium. OWEN, E. A., LIU, Y. H., AND MORRIS, D. P. *Nature, Lond.*, **161**, 681–2 (*May* 1, 1948).—Compressed Al samples were found to have an increased lattice parameter, which decreased exponentially with time to a "metastable" value somewhat > the true equilibrium value; the latter was only achieved after annealing. Foils made by compressing annealed filings of Al did not exhibit the "metastable" phenomenon. The surface crystals of filed and polished samples are concluded to be in the "metastable" state.

539.42 2609

Delayed fracture of glass under tension, torsion and radial pressure. GURNEY, C. *Nature, Lond.*, **161**, 729–30 (*May* 8, 1948).—A theory of the delayed fracture is briefly outlined. It is supported by experiments in bending, torsion and radial pressure, made on ¼-in annealed soda glass rods. L. S. G.

539.434 : 539.26 2610

A combined creep machine and X-ray spectrometer. TAPSELL, H. J., POLLARD, H. V., AND WOOD, W. A. *J. Sci. Instrum. Phys. Ind.*, **25**, 198–9 (*June*, 1948).—The machine described is used in the study of the mechanical properties of metals in relation to X-ray structure, particularly their creep behaviour at elevated temperatures. Special features incorporated in the design permit the X-ray examination of a specimen at various times while it is creeping under a stress which is kept constant throughout the period of uniform stretching, and the specimen is oscillating about its axis and the X-ray film oscillating in its own plane. A photograph and a diagram of the machine are shown. A.

539.501 2611

Rheology of foodstuffs. SCOTT BLAIR, G. W. *Research, Lond.*, **1**, 453–8 (*July*, 1948).—A short review, mainly concerned with the experimental methods available for investigation (93 refs.).

539.536 2612

Absolute measurements of the depth of abrasion, a testing method for dentifrices. EHRHARDT, J. J. *Appl. Sci. Res.*, **A 1** (*No.* 2) 87–93 (1948).—A sensitive interferometric method was developed for studying the abrasive effect of tooth-pastes. This method revealed also details in the structure of tooth-material. A.

PHYSICAL CHEMISTRY 541

REACTION KINETICS 541.124/.128

541.127 2613

Aspects of a theory of unimolecular reaction rates. SLATER, N. B. *Proc. Roy. Soc. A*, **194**, 112–31 (*July* 28, 1948).—A uniform gas of polyatomic molecules is treated as an assembly of classical vibrating systems, which dissociate when one internal co-ordinate q reaches a critically high value q_0 which is related to the dissociation energy E_0. The unimolecular velocity constant at temperature T is found to be $K = \nu \exp(-E_0/kT)$, where the "frequency factor" ν lies in the range of molecular vibration frequencies. The factor ν is interpreted. The dissociation rate is formulated in several ways, which represents different aspects of the physical picture. A.

541.127 2614

The mechanism of the carbon dioxide-carbon reaction. GADSBY, J., LONG, F. J., SLEIGHTHOLM, P., AND SYKES, K. W. *Proc. Roy. Soc. A*, **193**, 357–76 (*July* 2, 1948).

541.127 2615

The mechanism of the steam-carbon reaction. LONG, F. J., AND SYKES, K. W. *Proc. Roy. Soc. A*, **193** 377–99 (*July* 2, 1948).

541.128 : 541.183 2616

The physical approach to contact catalysis. ELEY, D. D. *Research, Lond.*, **1**, 304–9 (*April*, 1948).—A short review (47 refs.).

ELECTROCHEMISTRY 541.13

541.13 : 621.357 : 669.797.2 2617

Electrochemistry of indium. MOELLER, T., AND HOPKINS, B. S. *J. Electrochem. Soc.*, **93**, 84–93 (*March*, 1948).—Available electrochemical information is discussed for the evaluation of the ease of reduction of In compounds, the case of oxidation of the metal, the relative ionic characteristics of the compounds in the pure conditions and in solution, and the quantitative estimation of the element. The quantity production of In metal in a high state of purity is shown to be based primarily upon knowledge of its electrochemical characteristics. Baths suggested for the electro-deposition of In may be classified roughly as those containing simple In compounds such as the sulphate, those containing added organic compounds such as formic and Rochelle salt, and baths containing added cyanide. H. H. HO.

541.135.5 : 537.311.3 *see Abstr.* 2468

COLLOIDS . DISPERSE SYSTEMS 541.18/.182

541.182.2 : 551.578.11 : 532.6 *see Abstr.* 2372

541.182.6 : 538.61 *see Abstr.* 2512

ADSORPTION 541.183

541.183 : 541.128 *see Abstr.* 2616

ATOMIC THEORY 541.2

541.24 : 541.64 *see Abstr.* 2618

CHEMICAL STRUCTURE 541.4/.6

541.57 : 539.132 *see Abstr.* 2514

541.64 : 541.24 26

The size and shape of polymer molecules. BAW C. E. H. *Research, Lond.*, **1**, 343–52 (*May*, 1948). After an introductory section in which the significance molecular weight and structure of the molecule for t physical properties of the material in bulk is discusse this article reviews the various methods available f investigation and study (16 refs.).

CHEMICAL PROCESSES 542.9

542.9 26

Recent advances in science. General and physi chemistry. SMITH, J. W. *Sci. Progr.*, **36**, 273–83 (*Ap* 1948).—The trans-uranic elements and their chemi significance (6 refs.).

542.9 26

Note on some theoretical discussions of palladiu hydrogen and cognate systems. SMITH, D. P. *Phil. Ma* **39**, 477–81 (*June*, 1948).—A review and co-ordinati of work previously published. A bibliography of references. L. S.

542.9 : 539.163 *see Abstr.* 2544

CHEMICAL ANALYSIS 543/545

545.8 26

Determination of radioactive and stable tracer isotop *Nature, Lond.*, **161**, 693–5 (*May* 1, 1948).—A short rep of a discussion, covering estimation of β-radioactivi relative abundances of inactive isotopes by ma spectrometer and other methods; examples of the use tracer isotopes.

545.824 = 4 26

Precise quantitative X-ray analysis of binary and terna mixtures of anhydrous calcium carbonate. STOLKOWSKI *C.R. Acad. Sci., Paris*, **226**, 933–4 (*March* 15, 1948) *French.*

CRYSTALLOGRAPHY 548

548.0 : 537.529 *see Abstr.* 2483

548.0 : 539.32 *see Abstr.* 2602

548.5 2623

The formation of crystals of spectroscopically pure iron. PHILLIPS, D. L. *Research, Lond.*, **1**, 479–80 (*July*, 1948).—Small crystals were formed on the surface of mild steel rods heated for 4 days at 1 000°C in sealed evacuated silica sheaths. In all instances, the formation of a crystalline deposit was accompanied by the pitting of adjacent areas of the steel surface.

548.7 : 535.343.2 *see Abstr.* 2416

548.7 : 536.48 : 538.214 *see Abstr.* 2504

548.7 : 539.24 *see Abstr.* 2600

548.7 : 539.32 *see Abstr.* 2603

548.73 : 539.4.016.2 *see Abstr.* 2608

548.733 26

A rapid method for preparing powder camera specim with cellulose acetate capillary tubes. BEU, K. E., A CLAASSEN, H. H. *Rev. Sci. Instrum.*, **19**, 179–80 (*Mar* 1948).

548.733 26

The positive print method of measuring X-ray reflexi from a single crystal. WOOD, R. G., AND WILLIAMS, *J. Sci. Instrum. Phys. Ind.*, **25**, 202–4 (*June*, 1948)

A photometer is described suitable for use in Dawton's positive print method for determining the relative intensities of X-ray reflections from single crystals. A brief discussion is given of the determination of the standardized processing conditions. A.

548.733 2626

An improved technique for setting single crystals from zero layer-line photographs. WEISZ, O., AND COLE, W. F. *J. Sci. Instrum. Phys. Ind.*, **25**, 213–14 (*June*, 1948).—The technique permits the easy determination of the errors in the two goniometer arcs from a single composite stationary-crystal photograph taken with one arc parallel to the beam, and the other perpendicular to it. The method involves a minimum of calculation and is rapid and reliable. A.

548.733 2627

An X-ray glancing angle and back-reflexion camera. HOWARTH, J. L. *J. Sci. Instrum. Phys. Ind.*, **25**, 231–4 (*July*, 1948).—The camera was designed for general purposes, particularly identification work, the glancing angle camera being intended to give for lump specimens as good a substitute as possible for a powder photograph. It was important to make provision for fairly large and awkwardly shaped specimens. The relative merits of various forms of film and specimen movement are discussed. A.

548.734.4 2628

The adjustment of a crystal from X-ray rotation photographs. BAIRSTO, A. *J. Sci. Instrum. Phys. Ind.*, **25**, 215–16 (*June*, 1948).—A method of correcting small errors in the setting of crystals for X-ray rotation and oscillation photographs is described. Complete rotation photographs are used, and this makes the method applicable when, owing to an insufficient number of spots to define the zero-layer curve, previous methods using small-angle oscillation photographs are unsatisfactory. Three complete rotation photographs are taken at slightly different crystal settings, and the correct orientation is worked out by a simple graphical method. A.

548.734.842.4 2629

Phase-angle determination in X-ray crystallography. STOKES, A. R. *Nature, Lond.*, **161**, 679–80 (*May* 1, 1948).—Two objections to Booth's argument [Abstr. 3243 (1946)] are pointed out. (*a*) The disturbances causing the diffuse reflections need not possess centro-symmetrical symmetry. (*b*) The phase angle of a reflection is not an absolute quantity, but depends on the position taken for the origin of the unit cell of the structure.

548.735 2630

The accuracy of atomic co-ordinates derived from Fourier series in X-ray crystallography. V. BOOTH, A. D., AND BRITTEN, K. H. V. *Proc. Roy. Soc. A*, **193**, 305–10 (*July* 2, 1948).—A modification of previous work [Abstr. 1050, 3362 (1947)]. The question of how the experimental error in the co-ordinates varies with the position of the atom in relation to its neighbours is investigated, and it is shown that the variation is much smaller than that previously derived for finite summation errors. A.

548.735.4 2631

The correction of X-ray intensities for polarization and Lorentz factors. COCHRAN, W. *J. Sci. Instrum. Phys. Ind.*, **25**, 253–4 (*July*, 1948).

548.735.44 : 518.5 2632

Three-figure cosine factors for Fourier analysis and synthesis. II. A mechanical sorting device. ROBERTSON, J. M. *J. Sci. Instrum. Phys. Ind.*, **25**, 216–18 (*June*, 1948).—The device automatically sorts and arranges the cosine factor strips described earlier [Abstr. 803 (1948)], and presents the figures required for Fourier analysis or synthesis, or for structure-factor calculations, in a convenient row ready for addition. A.

MINERALOGY 549

549.211 : 537.226.2 *see Abstr.* 2464

BIOLOGY 57/59

576.8.097 : 539.21 2633

Nature of forces between large molecules of biological interest. PAULING, L. *Nature, Lond.*, **161**, 707–9 (*May* 8, 1948).—A lecture in which the shapes of, and forces between, large molecules are discussed. It is suggested that antibodies and antigens have complementary molecular structures; and that when a molecule of an antibody is brought into the presence of a molecule of antigen that configuration is taken up, which is stabilized by interaction; in this there is the greatest force of attraction between the two molecules. The specificity of the activity of large molecules (e.g. of haemoglobin) is discussed. [See also *Endeavour* (*April*, **7**, 43–53, 1948)]. L. S. G.

591.185.63 : 525.37 : 531.114 2634

Remarks on: "A preliminary study of a physical basis of bird navigation." SLEPIAN, J., VARIAN, H., AND DAVIS, L., JR. *J. Appl. Phys.*, **19**, 306–8 (*March*, 1948).—Letters by each of the above authors commenting on the paper by Yeagley [Abstr. 1132 (1948)].

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.843.6 : 771.534.554 *see Abstr.* 2640

615.849 : 539.172.4 2635

Some biological effects due to nuclear fission. TOBIAS, C. A., WEYMOUTH, P. P., WASSERMAN, L. R., AND STAPLETON, G. E. *Science*, **107**, 115–18 (*Jan.* 30, 1948).—In neutron therapy, localized effects may be artificially produced in an animal body, if one deposits in an organ an element the cross-section of which is relatively high for a suitable slow neutron-induced transmutation. Kruger [see Abstr. 1949 (1940)] used B, the present authors have used enriched U^{235} (95%) in the form of UO_2 colloid administered intravenously to mice. The mice were later irradiated by a sublethal dose of $1{\cdot}7\times10^{12}$ slow neutrons/cm² considered equivalent to 310 r of 150 kV X-rays. All mice died in 3 weeks. Control experiments demonstrated that U fission was important in causing lethal effects. Typical distribution of U in the tissues of mice was: liver, 58%; spleen, 25%. The dose to the spleen due to fission recoils was about 15 000 r.e.p. One r.e.p. (roentgen equivalent physical) = 83 ergs/gm. In addition it was estimated that the delayed effects of the radioactive fission product contributed 3 000 r.e.p. T. A. C.

GLASS . CERAMICS 666

666 : 538.22 *see Abstr.* 2505

METALLURGY 669

669.797.2 : 621.357 : 541.13 *see Abstr.* 2617

771.534 2636

Absolute sensitivity measurements on single-grain-layer photographic plates for different wave-lengths. WEBB, J. H. *J. Opt. Soc. Amer.*, **38**, 312–23 (*April*, 1948).—Single-grain-layer photographic plates were prepared from a non-colour-sensitized, slow-speed, uniform-grain-size emulsion and exposed to very pure monochromatic light of wavelengths 3 600, 4 500, and 5 000 Å. Intensity-scale characteristic curves were made on a double monochromator in which the energy of the exposures could be measured with an accuracy of ±5%. Data for plotting the characteristic curves were obtained by microscopic grain counts of developed and undeveloped grains for successive exposure steps. Experimentally, it is found that the characteristic curves increase their slope with increasing wavelength of exposing radiation and also show a tendency to increase in slope with decreasing development time. The curves are analysed using the Poisson statistical equation to determine the number of quanta actually utilized in formation of the latent image. Preparatory to this analysis, exposures were made to α-particles. The single-grain-layer plates accurately obey the single-hit formula derived from the Poisson equation. From the analysis of the curves obtained with monochromatic light exposures, it is concluded that the threshold sensitivity of a grain, expressed as the min. number of quanta to produce developability of the grain, $\simeq 10$ quanta/grain for the emulsion under test. The upper limit of sensitivity is specified by the number of quanta absorbed per grain as shown by the abscissae of the characteristic curves. A.

771.534.1 2637

The influence of static pressure on the sensitivity of photographic emulsions. I. BÄCKSTRÖM, H. *Ark. Mat. Astr. Fys.*, **35 A** (*Paper* 20) 36 *pp.* (1948).—An emulsion exposed under static pressure has a lower developed density than for the same exposure without pressure. Pressure applied before or after light exposure does not produce a density difference, nor does any density result from static pressure applied to the unexposed emulsion. The density difference, ΔD, varies with material used, applied pressure, wave-length and intensity of light and duration of exposure. Typical ΔD values for fast panchromatic emulsions are 0·2 to 0·5 for 1 000 to 2 000 kg/cm², and exp. time $\frac{1}{20}$ sec. The effect is reversible, and may be explained by latent image theory as resulting from a reduction of electrolytic conductivity of AgBr by pressure, leading to lowered photographic efficiency. D. R. B.

771.534.3 : 539.16.08 2638

Background eradication of nuclear emulsions by accelerated fading of the latent image. YAGODA, H., AND KAPLAN, N. *Phys. Rev.*, **73**, 634 (*March* 15, 1948).—The normal fading of latent images, formed by α particle tracks, in stored fine-grain nuclear emulsions may be accelerated by exposure to moist (saturated) air at 35°C; or the image may be destroyed completely by storage at 25°C for 4 hr over 3% H_2O_2. Storage in fresh distilled water has no effect. The method cleans up background of α tracks, and stars due to Ra and Th impurities. It is inapplicable to coarse-grain, light-sensitive emulsions. Loading nuclear emulsions with borax or Li salts inhibits action of H_2O_2; thus exposure to eradicator must precede loading. On desiccation over $CaCl_2$ (1–2 hr) sensitivity of cleaned emulsion is restored. D. R. B.

771.534.53 = 3 2639

The blackening function of a complete photographic process. KINDER, W. *Optik*, **2**, 196–9 (*Aug.*, 1947) *In German.*—The properties of photographic emulsio permitting equality in the distribution of brightnesses object and final print are deduced. A series of math matical functions based on an equation of a characteris curve are derived. These lead to a simple expressi according to which the straight-line part of the characte istic curve may fulfil the conditions mentioned above. R. H.

771.534.553 : 778.33 *see Abstr.* 2642

771.534.554 : 612.843.6 26

Photographic granularity and graininess. IV. Visu acuity thresholds; dynamic versus static assumptio JONES, L. A., AND HIGGINS, G. C. *J. Opt. Soc. Ame* **38**, 398–405 (*April*, 1948).—[See Abstr. 2365 1947)]. T distances at which a series of rectangular test objects a visible were determined experimentally. The objec were black opaque rectangles and were viewed again a transluminated background. Using these data, and assumed nystagmic motion of the eyeball, the *summat temporal illuminance gradients* on the retina were fou to be essentially constant, even though the length-wid ratios of the test objects varied from 1 to 4 05 Assuming a motionless eyeball, that is, perfect fixatio the summated values of ΔI were computed for the sa observational conditions, ΔI being defined as t difference between the average illuminance incide on adjacent cones in the retinal mosaic. The valu of summated ΔI are not constant. Since all of the test objects were just visible at the distance measure they may be considered as being equal to each other wi respect to their ability to excite a threshold neur response. It may be concluded, therefore, that since t values of the summated temporal gradients are consta they are the most significant indices of the relati magnitudes of the neural responses.

777.9 : 548.5 26

Photography on selenium. SELÉNYI, P. *Nature, Lond* **161**, 522 (*April* 3, 1948).—The crystallization amorphous Se (e.g. a film on Al or steel disc) is accelerate by illumination, changing from black to grey. A positi image is produced in 1–2 min at 90–95°C of an optic image projected on to the surface. The Se surface mu first be polished (i.e. covered with fine scratches) facilitate regular crystallization.

778.33 : 771.534.553 26

Resolution testing in autoradiography. STEVEN G. W. W. *Nature, Lond.*, **161**, 432–3 (*March* 20, 1948).— An active chart for testing contact radiography resolutio was made by converting a Ag test image on a hig resolution plate to AgI^{131}. A photomicrograph of t chart, and an autoradiograph obtained from it, are show

778.37 : 621.791.73 26

High-speed photography of welding arcs. BRAILSFOR F., AND SHRUBB, K. F. *J. Sci. Instrum. Phys. Ind.*, 2 211–13 (*June*, 1948).—A description is given of a hig speed camera used for photographing the transfer metal in the metallic arc process of welding. It may used at speeds up to 2 500 pictures per sec, taking successive frames on a 25-in length of 35-mm ciné fil An optical compensator system is employed with rotating glass prism interposed between the camera le and the continuously moving film. The operating tec nique is described and examples of work done with t camera are given, including photographs of a carbon a on an a.c. supply, and of metal being transferred fro a coated welding electrode to a work-piece.